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COLUMBIA-NORTH PACIFIC REGION COMPREHENSIVE FRAMEWORK STUDY OF --ETC(U)
SEP 72 E J GULLIDGE, G J GRONEWALD

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This Main Report and the supporting appendices make up the complete Columbia-North Pacific Region Framework Study on water and related lands. A complete list of the several documents is shown below:

Main Report

Brochure Report

Appendices

I. History of Study

II. The Region

III. Legal & Administrative Background

IV. Land & Mineral Resources

V. Water Resources

VI. Economic Base & Projections

VII. Flood Control

VIII. Land Measures & Watershed Protection

IX. Irrigation

X. Navigation

XI. Municipal & Industrial Water Supply

XII. Water Quality & Pollution Control

XIII. Recreation

XIV. Fish & Wildlife

XV. Electric Power

XVI. Comprehensive Framework Plans

Pacific Northwest River Basins Commission
1 Columbia River
Vancouver, Washington

(1)

MAIN REPORT

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of Water and Related Lands. Main Report,

(10) E. J./Gullidge, G. J./Gronewald,
H. H./Ralphs, G. E./Van Santen
N. S./Andresen

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Submitted by

New Pacific Northwest River Basins Commission
Vancouver, Wash~~ington~~

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This Main Report of the Columbia-North Pacific Region Comprehensive Framework Study was prepared at field level under the aegis of the Pacific Northwest River Basins Commission. It is subject to review by the interested Federal agencies at the departmental level, by the Governors of the affected States, and by the Water Resources Council prior to its transmittal to the President of the United States for his review and ultimate transmittal to the Congress for its consideration.

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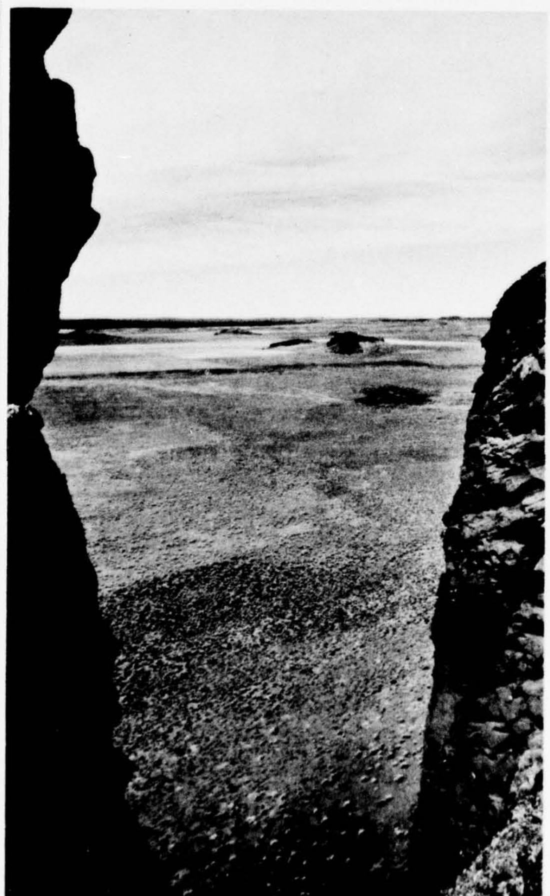
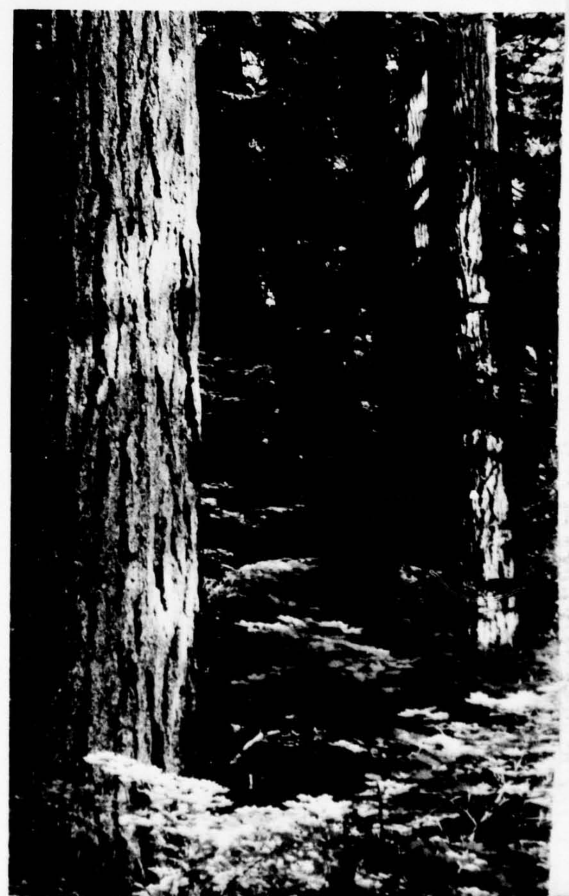

SUMMARY

This report, prepared by State and Federal agencies under the aegis of the Pacific Northwest River Basins Commission, presents the results of comprehensive investigations of water and related land resources of the Columbia-North Pacific Region. The study appraises natural resources, projects future requirements and associated problems, and provides broad framework plans and programs for management and development of resources to the year 2020 and the intermediate years of 1980 and 2000. Also included is a general estimate of costs and a program of implementation. These framework plans and programs were based on available data and formulated using general relations, reasoned approximations, and the judgment of experienced planners.

The framework plans and programs outlined in this report are presented not as the final word of some governing body, but as a compendium of measures which, after examination and critical discussion, have been thought by the study participants to contribute to a balanced use of water and related land resources.

As planning of water and related land resources is for the purpose of satisfying the future, the effort hinges on projections of future growth. National interregional projections developed by the United States Water Resources Council were used. These projected levels of population, economic activity, and agricultural productivity were considered to be only a representation of conditions that would exist in the future if past trends continued. They are indicators of potential growth and were not taken as goals or objective or as an assumption that past occurrence will continue into the indefinite future. Rather, the projections were used to formulate framework plans and alternatives as a baseline for further resource planning, protection, or development.

The framework plans and programs may be taken as a starting point whenever resource protection or development comes under consideration. By continuing refining and updating. They should assist in meeting the water and related land needs of the future.

Basic resources found in abundance in the Columbia-North Pacific Region are high quality water and land, as well as some minerals in sufficient quantities to be of economic significance. The principal limitation on the use of these resources is their distribution. Although water is abundant on an annual basis, most precipitation falls during the winter and in the western part of the region, resulting in a deficiency during the summer months, especially in the central and eastern parts. Other limiting factors include economic, political, and social considerations. The region has high natural environmental values, the retention of which, while sustaining an acceptable level of development and growth requires the best management, use, development, and conservation of water and related land resources.

The population of 6,374,000, 1970 census, is concentrated in the Seattle-Tacoma and Portland-Vancouver metropolitan areas. Future growth in population,

which will depend on the economic development, is projected to increase to 15.4 million by the year 2020. Approximately 70 percent of the regional population is projected to be located west of the Cascade Range by 2020. Total employment is estimated to increase from about 2.4 million in 1968 to 5.7 million in 2020. Municipal and industrial water requirements are expected to increase about three times, electric energy requirements over ten times, recreation water demand over five times, and flood damage will increase nearly four times by the year 2020 without additional zoning, control, and protection.

The framework plans and programs were formulated to satisfy functional needs that have been identified, giving full recognition given to preservation and enhancement of the natural environment. Available resources would provide opportunities for meeting most of the identified functional needs. However, in several Pacific Northwest river basins it will not be feasible to provide a full water supply to all of the presently irrigated water-short lands, to preserve all of the prime recreation streams, and, at the smae time, provide optimum streamflows for aquatic life and water quality. From the standpoint of the overall well-being of the area, these unmet needs are not considered particularly significant. The food production lost by not providing full supplemental supplies can be replaced through accelerated management techniques on presently irrigated lands or by a slight increase in new irrigation either in that area or elsewhere in the region.

Preservation and enhancement of environmental and esthetic values would be assured by:

Future studies leading to the establishment of realistic minimum flows on all streams and augmentation of low flows in many areas to improve esthetic values, fish and wildlife habitat, and to aid in pollution control.

Study of an additional 7,480 miles of highways for possible designation as scenic roads.

Study of over 10,500 miles of all or part of over 150 streams to determine their merits for inclusion with the presently designated 342 miles in a state or national system of recreation streams and subsequent designation of those found to qualify.

Landscape management control.

Environmental and esthetic qualities would also be preserved and enhanced by measures for water quality, flood plain management, fish and wildlife, recreation, and watershed management and treatment. All of these items are listed and described in subsequent narrative.

Electric power would be provided by:

Installation of additional capacity of 14,370 MW at existing and new hydro-

electric plants and 143,800 MW of thermal power by 2020, using evaporative cooling at inland locations and direct cooling in coastal areas with ocean water.

Thermal plants would requiremover 2.1 million acre-feet of water by 2020, all of which would be for consumptive use. Some additional salt water will be required if once-through cooling is used in the coastal plants but this would not be a consumptive use.

Additional peaking resources of 26,600 MW required by 2020 will be developed from pumped storage and thermal sources, but it is not possible to determine the amounts of each that will be developed.

Commercial water transportation needs would be met by:

Deepening the lower Columbia River channel and other deep-draft channels and construction of 16 miles of breakwater by 2020. Over half the channel work would be in Subregions 8 and 9 and all the breakwaters in Subregions 10 and 11.

Improvement of the existing Bonneville locks in the early time period, and extension of barge navigation on the upper Columbia River by channel improvements and construction of three locks in existing dams after 1980 if found to be acceptable by recommended interdisciplinary studies.

Improvement of the channel in Willamette River and of the locks at Willamette Falls after 1980.

Expansion of port facilities along the existing and expanded navigation channels and additional moorage and launching facilities for small boats in all subregions.

Water quality would be improved by:

Waste Treatment to remove 85 percent of organic wastes from municipal and industrial effluents by 1980, and 90 percent by 2000. In the Puget Sound area, future treatment of wastes which are discharged into marine waters will be determined by a Federal and State studies which are now underway. Requiring cooling ponds, towers, or mechanical draft cooling to minimize any discharge of warm water into fresh water streams or lakes by thermal electric powerplants.

Municipal, industrial, and rural domestic water supplies would be provided primarily by:

Additional withdrawals from existing sources and development of some new sources to permit the withdrawal of an additional 6,166,000 acre-feet by 2020. About 67 percent would come from surface supplies. The total water

demand increase is 5,495 MGD with municipal systems requiring 2,406 MGD and industrial users 2,912 MGD. The remaining 177 MGD would be required for rural-domestic use.

Flood control would be provided by:

Flood plain management including preparation of flood plain information reports to provide guidance for flood plain zoning, and flood proofing at 148 initial locations, and by levees and channelization totaling about 1,300 miles. Only 12,000 acre-feet of single-purpose flood control storage would be included; however, 17.1 million acre-feet of joint-use storage would be utilized for flood control. The use of non-structural and structural measures to reduce the growth in flood damages along major streams by 75 percent. Significant reductions in bank erosion damages and in flood damages along minor streams would also be provided by measures programs, although these reductions were not evaluated in terms of dollars.

Food and fiber production needs would be met by:

Development of nearly 23 million acre-feet of water, including over 19.4 million acre-feet from surface sources. Water would be provided for 1.5 million acres of the 2.0 million acres of presently irrigated water-short land and over 6 million acres of new irrigation to furnish 42.3 million tons of additional production. Although dry-land crop yields have been projected to increase substantially, the acreage is expected to decrease, resulting in about 0.5 million tons less food and fiber production from non-irrigated land.

Storage facilities proposed include:

Multiple-purpose installations with about 17 million acre-feet of capacity and single-purpose flood detention dams with 12,000 acre-feet capacity. Multiple-purpose storage would regulated flows for irrigation, flood control, esthetics, recreation, municipal and industrial water, water quality, power, navigation, and fish. The final location and scoping of storage would depend on the plan selected by detailed interdisciplinary studies. In addition, nearly 70,000 ponds and small reservoirs are planned which would add about 531,000 acre-feet of storage. Water quality storage will be reviewed in implementation studies on the basis of current Federal policy.

Fish and Wildlife needs would be met by:

Preservation and protection of fish habitat on nearly 14,000 miles of streams; improvement of habitat on 33,400 miles of streams and 422,000 acres of lakes; augmentation of the supply of fish by enlarging existing hatcheries, building 144 new hatcheries and providing 11,000 acres of rearing ponds; and providing access to 9,851 miles of streams and at 1,407

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sites on lakes and 472 sites on salt water. These and other related activities would provide an additional 42.8 million user-days of ishery recreation between 1970 and 2020.

Land acquisition or control of an additional 3.8 million acres for specific wildlife preservation and management; improvement of wildlife habitat on 10.1 million acres; and annual production of 680,000 game birds. Access would be improved to nearly 60 million acres. Through these and other activities, 13.1 million user-days of hunting would be provided.

Water-related recreation needs would be met by:

Developments to provide for an additional 422 million recreation days by 2020. This would require facility development on an additional 208,900 acres of land between 1970 and 2020, and use of 1,870,000 acres of water surface by 2020 as compared to the present need for only 368,000 acres of the more than 2.5 million acres of available fresh water surface. About 98,000 acres of land would be acquired primarily for urban recreation.

Study of 2.7 million acres of land to determine those portions which should be designated as wilderness or primitive areas.

Watershed Management and treatment would be accomplished by:

Erosion and sediment control practices on 32 million acres; water yield improvement on 612,000 acres of forest land; water conservation on over 6 million acres; protection and management on nearly 100 million acres; cropland drainage on 1,347,000 acres; cooperative accelerated treatment and development of up to 896 watersheds; 17,100 miles of bank stabilization; 4,289 miles of dikes and levees; channel improvement on nearly 29,400 miles; and nearly 70,000 ponds and small reservoirs with a total capacity of 531,000 acre-feet. Full consideration will be given environmental values as part of the evaluation process in implementation studies channels of structures affecting streams.

One of the most important products of the study is the identification of complex problems warranting further investigations. The studies which are a part of the framework plan include:

Coastal zone and estuaries to develop a coordinated plan.

Watersheds to select those which are justified and desired by local interests to help meet the needs for water and soil conservation, water supply, and food and fiber.

River basins to select the best alternatives where complex problems, wide array of alternatives, and lack of available data require interdisciplinary studies.

Special studies to obtain facts for planning.

WATER SITUATION

Under 1970 conditions, the total average annual surface-water runoff of the region was 310,000 cfs (224 million acre-feet). In addition, the flow into the region from Canada contributed another 74,000 cfs (54 million acre-feet) making a total of 384,000 cfs or 278 million acre-feet annually. Approximately 240,000 cfs (175.7 million acre-feet annually) were in the Columbia River system. Even with this large quantity, water is not always available wherever needed because of areal distribution and the timing of runoff.

Ground water is also an important element in current and projected use. The region contains roughly 550 million acre-feet in the top 50 to 100 feet of the water-bearing strata. Gross annual recharge is estimated to be 120 million acre-feet annually. However, some of the water moves from surface to ground water two or three times in its travel so that the net annual recharge is probably on the order of 100 million acre-feet.

Total annual ground-water withdrawal was estimated to be about 4.9 million acre-feet in 1970, of which about 3.6 million acre-feet were for irrigation and 1.3 million acre-feet for municipal, industrial, and rural-domestic water supply. Ground-water withdrawals are estimated to increase to 10.6 million acre-feet by 2020 when depletions could be about 5 million acre-feet. About half of the withdrawals and depletions would be in the Snake River Basin, with the remainder distributed about evenly among the other areas. Although the Pacific Northwest has large quantities of ground water, additional development of them would add little to total water supplies and, in some places, could contribute to already critical streamflow conditions. This latter condition may be especially true in the Snake River Basin of Southern Idaho where the bulk of the ground-water use takes place.

Withdrawal of surface and ground water in 1970 approximated 41.0 million acre-feet of which 33.7 million acre-feet were used to irrigate 7.5 million acres of land. The total depletion was estimated to be 16.9 million acre-feet, 86 percent of which was from surface supplies. Estimates of water withdrawals indicate that by 2020 withdrawals for irrigation would increase to 56.7 million acre-feet and withdrawals for other purposes would be about 18.7 million acre-feet. Depletions by 2020 are estimated at 33.7 million acre-feet, 85 percent of which would be from surface water; irrigation would cause 83.5 percent of these depletions.

Estimates of flows remaining by 2020 leave the impression that large quantities of water are available at all times. This is not a true picture. Water is not always available as needed because of areal distribution and the timing of runoff. For example, the average annual flow of the Snake River at Weiser in 1970 was 15,070 cfs. By 2020, projected irrigation and other upstream developments could reduce the average annual flow at Weiser to between 9,000 and 9,600 cfs. In addition, an estimated 389,000 acres of presently irrigated lands would still be water short. Based on average flows alone, serious conflicts

arise between irrigation diversions and instream needs. When considering the limited upstream storage opportunities and flows during dry periods, the conflict is even more serious. Therefore, a detailed study of the Snake River Basin is included in the framework plan to evaluate the potential for additional storage and ground-water withdrawals with full consideration for maintaining instream flows.

Instream use of water is of paramount importance to the region where it is used repeatedly for hydroelectric power production, recreation, navigation, fish wildlife, esthetics, and water quality control. Flowing waters in the stream represent an improtant part of the region's natural environment. The importance of these uses to the people of the region and the nation cannot be overemphasized.

Water quality in the region is generally very good, but there are some serious pollution problems which damage fisheries and create undesirable public health and esthetic conditions. Waste discharges return flows and improper land use are the principal factors contributing to water quality degradation.

LAND SITUATION

With proper management the land resources are adequate to meet projected water related needs and to retain the area's environmental characteristics. The plan seeks to meet the projected needs of man with the least detrimental effect on the environmental and nonrenewable resources.

There are almost 51.1 million acres with soils, topography, and climate suitable for cropping. Only 20.8 million acres are being cropped, and the plan calls for a modest increase of 4 percent to 21.7 million by 2020. About 42 percent of the arable land would be cropped by 2020. The major change is a shift from nonirrigated to irrigated cropland, with irrigated cropland increasing about 84 percent and dry cropland decreasing 37 percent. About 40.4 million acres are considered to be irrigable and, by 2020, 13.5 million acres would be irrigated under the plan, an increase of 6 million acres in 50 years, but only one-third of the ultimate potential.

There would be an increase in the other land category from 8.3 to 10.5 million acres in 2020, an increase of 26 percent. This increase is represented by areas for urban, industrial, transportation, and recreation uses, and small ponds and reservoirs.

The increases in crop and other lands are expected to be met largely at the expense of the forest and rangelands. Programs to offset this areal reduction and still meet the increased food ang fiber nneds would consist mostly of more intensive management. Projections indicate the forest area will decline from 85.8 to 84.2 million acres by 2020, primarily commercial forest land; the 58.7 million acres of range will decline to 56.5 million acres during this same period.

IMPLEMENTATION

This study provides a flexible framework pf plans and programs as a first step in a sequence of comprehensive planning efforts. A framework is evolved which provides local, State, and Federal interests with a guide for management, use, development, and preservation of the water and related land resources of the Northwest as well as supplying a basis for accomplishing further planning.

These framework plans and programs form a basis for the comprehensive joint plan for Federal, State, interstate, local, and nongovernmental development of water and related land resources being prepared by the Pacific Northwest River Basins Commission pursuant to Title II, section 201(b) (2) of Public Law 89-80, the Water Resources Planning Act. As this legislation specifies that the Commission shall prepare and keep up to date, to the extent practicable, a comprehensive plan, there is an adequate continuing process for maintaining the plans and programs developed by this study as a viable framework for planning and managing the region's water and related land resources. Also, specific authorization studies by Federal or State agencies would be required prior to actual implementation of a project or program. Legislation as outlined in the report also would be needed.

The framework plans and programs meet a need based on projections of possible future conditions derived primarily on a nationwide basis. These projections were not taken as goals or objectives or used as an assumption that past trends will continue in the future. They were used as a baseline or level of reference for further resource planning, protection, or development. This use of an early action program for the 1970-1980 time period requiring expenditures of $6.34 billion in Federal funds and $5.92 billion in non-Federal funds, a program so large that it is unlikely to be totally implemented because of time and budgetary constraints. The largest amounts would be in related land programs, irrigation, and reservoir storage, which would represent more than 60 percent of the total investment by 1980 and by 2020.

The high cost of the related land program in the early action period results from emphasis on restoration of badly eroded crop, forest, and range lands to regain full productivity. Delays would cause continuing erosion and sedimentation problems that the programs are designed to curtail.

The large funding requirement in the early action program is influenced more by irrigation than any other one function because of its direct relation to the food and fiber projections. Reservoir storage is largely associated with Federal irrigation so their priorities would be determined by projects they are designed to serve. The only Federal irrigation projects which could probably be implemented during the initial period are those already under construction, those authorized for construction, or those for which basic planning is complete. If a all of those projects could be in operation by 1980, they would satisfy about 30 percent of the projected 1980 need for new irrigation, and firm up water supplies to about 14 percent of the water-short lands. If private development maintained

its past level of development, about 30 to 40 percent of the 1980 requirements could be met by that source. By combining the Federal and private potentials, it appears that about 60 to 70 percent of the early action irrigation program is all that could be realistically anticipated and even this would require accelerated Federal programs..

Most of the other elements of the early action phase of the framework plan represent a level of achievement which should be approached if at all possible. Electric power is sized to meet the load growth of the region. Water quality and municipal and industrial water supply programs are essential to the well-being of people. The relatively small navigation and flood control elements are considered to be a minimum. The level of the water related recreation plan should be expanded. Fish and wildlife measures are essential to retain this resource and to enhance it where possible.

Studies of rivers for recreation and fish and wildlife purposes, and of the coastal zone with its several estuaries have either not been undertaken or were inadequate in the past. Consequently, there is a large unmet need currently facing the region. If such studies are not undertaken in the next few years, the resultant delays in the early action study program will be reflected by increased programs in later time periods.

Further studies are required to realign the early action program to place the less important items in a later time period. For the most part, these adjustments will be made in the comprehensive joint plan being prepared by the Pacific Northwest River Basins Commission. These future studies would update the framework plans and programs and include the requisite public involvement to insure that the views of the public are fully incorporated into the plans and programs.

RECOMMENDATIONS

The report recommends:

1. That framework plans and programs form the basis for the comprehensive joint plan for Federal, State, interstate, local, and nongovernmental development of water and related land resources of the Pacific Northwest River Basins Commission pursuant to section 201 (b) of Public Law 89-80, the Water Resources Planning Act. Further studies would up-date the framework investigation and provide an input to plans of individual states and become a part of the Western U.S. Water Plan.

2. That framework plans and programs be adopted for general use for planning by state and local agencies and as a supporting document for individual Federal agency authorization reports.

3. That ongoing studies and programs for management and development of water and related land resources be accelerated.

4. That legislative changes and the studies proposed in the section on Implementation of Framework Plans and Programs, be given high priority, with special emphasis on providing legal and administrative means for enforcing minimum streamflows.

5. That projects and programs required to meet near-future projected needs be implemented through appropriate action by involved agencies and interests.

6. That Pacific Northwest River Basins Commission foster a periodic review and updating of the framework plan to maintain it as a viable planning guide for the Region.

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"All the rivers run into the sea; yet the sea is not full; unto the place from whence the rivers come, thither they return again." ECCLESIASTES 1:7

INTRODUCTION

The Columbia-North Pacific Region occupies 274,400 square miles in the northwestern corner of the United States. It includes all of the Columbia River Basin in the United States, those basins in Oregon and Washington draining into the Pacific Ocean and adjoining waters, and that part of the Great Basin lying in Oregon. The Pacific Ocean, with a coastline of sandy beaches, coves, and rugged headlands, outlines the western boundary. The sheltered waters of the island-dotted Puget Sound provide 2,500 square miles of an almost landlocked sea. A multitude of lakes range from alpine ponds to larger bodies such as Flathead, Pend Oreille, Chelan, and Coeur d'Alene lakes. The Columbia River system is the greatest unifying factor providing water supply, electric power, recreation, fish and wildlife, and an artery of transportation. With a harmonious combination of spectacular scenery, natural wonders, landscapes, and economic activities, the region is a unique area in the United States because of its high quality natural environment.

The framework study program for the Columbia-North Pacific Region stemmed from recommendations of the Senate Select Committee on National Water Resources, and planning concepts embodied in Senate Document No. 97, 87th Congress, Second Session. The overall program was presented by the President in the Fiscal Year 1963 budget. The Columbia-North Pacific Study was approved by Congress and funds were provided to start this activity late in 1965. The States of Washington, Oregon, Idaho, Montana, and Wyoming participated with the various Federal agencies in this investigation.

The purpose of this study is to provide a guide for the best management, use, development, and conservation of the region's water and related land resources. Accordingly, it provides a broad analysis of problems and a general appraisal of the probable nature, extent, cost, and timing of measures for their solution. Framework plans and programs were formulated for three time periods--1970-1980, 1980-2000, and 2000-2020--on the basis of initial planning steps using general relations, reasoned approximations, available data, and the judgment of experienced planners and after public meetings in various states. Individual project studies have not been undertaken, nor have inventories of all potential developments been made.

The framework plans and programs were developed with the following three broad objectives in mind.

First, *to enhance economic efficiency* by increasing the value of the Nation's output of goods and services and improving national economic efficiency.

Second, *to enhance the quality of the environment* by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems.

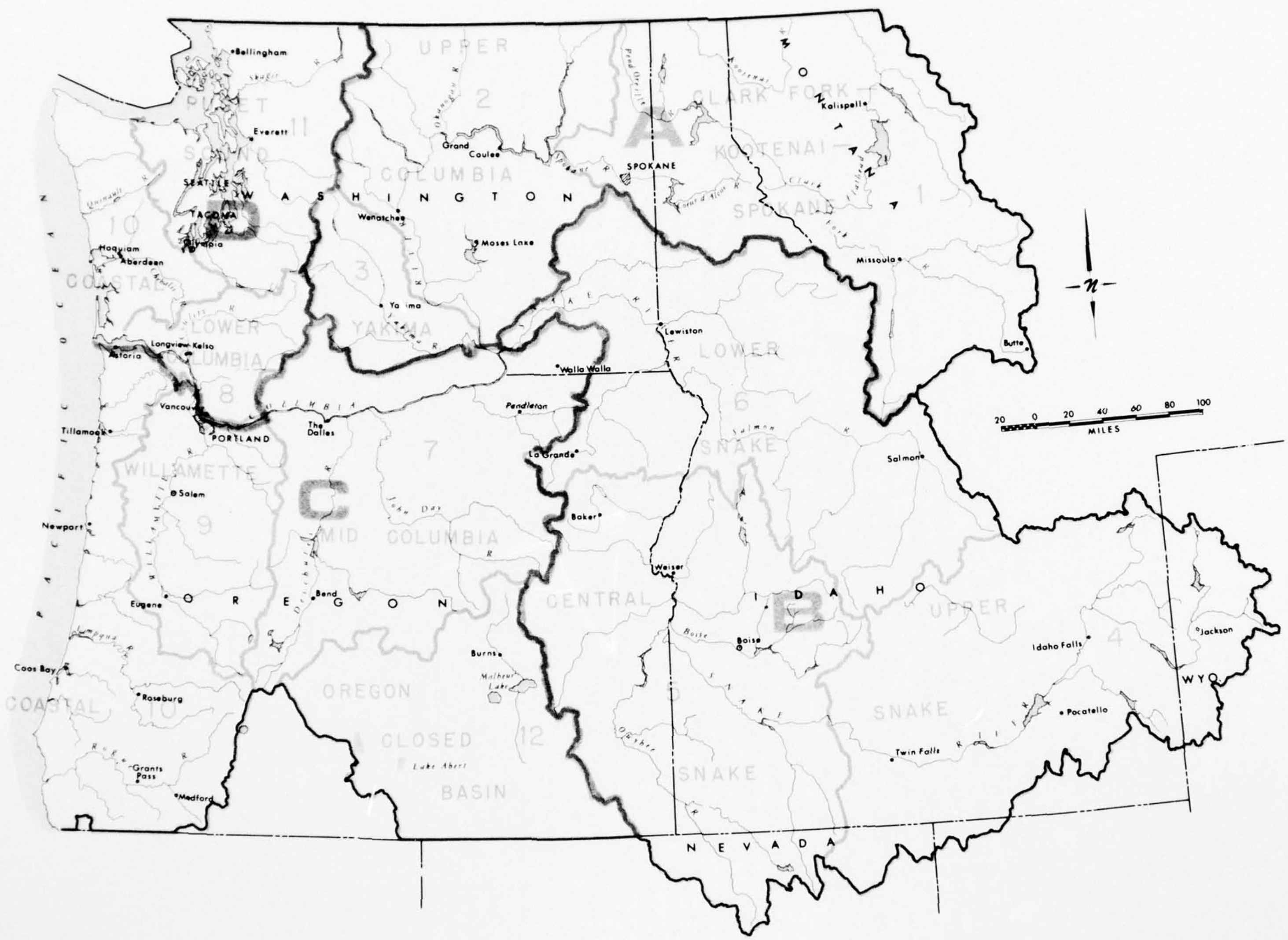


FIGURE 1. Plan Formulation Areas

Third, *to enhance regional development* through increases in the region's income; increases in employment; and improvement in its economic base, environment, social well-being, and other specified components of the regional objective.

These planning objectives, adopted by the Pacific Northwest River Basins Commission in 1968, are nearly parallel to the objectives described in the Water Resources Council's proposed "Principles and Standards for Planning Water & Related Land Resources" (Federal Register, Vol. 36, No. 245, Part II). Other objectives which have been considered are: acceptability, income redistribution, political equity, and population and industry distribution.

Economic projections used for the Columbia-North Pacific Region were developed from the 1968 national-interregional projections by the Office of Business Economics, Department of Commerce, and the Economic Research Service of the Department of Agriculture, and from special economic studies of the Willamette and Puget Sound areas. Some of the major assumptions used to develop these projections are:

1. Sufficient quantities of water of acceptable quality will be available for timely development to avoid being a constraint to economic growth.

2. The Federal Government, as a matter of national policy, will actively support programs designed to stimulate economic growth.

3. There will be no general war or any appreciable cessation of cold war throughout the period to 1980. Expenditures on national security will continue to account for approximately 10 percent of gross national product.

4. There will be a continued relaxation of trade barriers, tariffs, and quotas accompanied by an expansion in international commerce.

For study purposes, the Columbia-North Pacific Region was divided into 12 subregions, which were consolidated into four broad hydrologic-political areas for development of the regional framework plan (figure 1). Selection of subregional boundaries was based on hydrologic divisions considered usable for most water planning functions. As data used in the economic base studies and projections were available only by counties, economic subregion boundaries are along county lines, following, as nearly as possible the hydrologic boundaries.

The study effort was broken into five basic elements: an inventory, economic projections, development of future needs, framework plan formulation with full consideration of alternatives, and a program for implementation.

Some of the existing laws, policies, and treaties recognized during the planning process were:

Stream Management - Basic state laws dealing with appropriations, withdrawal, quality, diversion, and the operating plan for Columbia River Treaty storage.

Treaties and Compacts - 1910 Boundary Waters Treaty with Canada, 1964 Treaty with Canada on cooperative water resource development, treaties with Indian Tribes, and a compact between Idaho and Wyoming.

Electric Power Agreements - Federal Power Commission licenses and Pacific Northwest Coordination Agreement.

Administrative Controls - Water Resources Council guidelines and controls, and policies relating to Indian Tribes.

Overall guidance to the six plan formulation task forces was given by a Regional Plan Formulation Task Force composed of Federal department and State representatives. This group also had responsibility for developing regional plans and programs and preparing the Regional Summary for Appendix XVI, Comprehensive Framework Plans.

This Main Report summarizes and integrates the findings reported in the appendices and presents the framework plans and programs as a guide for future planning in the Columbia-North Pacific Region. The data, facts, projections, and topic matter discussed herein are substantiated in Appendix XVI, Comprehensive Framework Plans, and in greater detail in the various functional appendices.

The following concepts and definitions are essential to an understanding of this report:

Framework Concept (Type 1 Studies) This is the type of study covered by this document. It is a study of a region coordinated by a river basin commission or other Federal interagency-State coordinating organization that provides economic projections of economic development, translation of such projections into demands for water and related land resource uses, hydrologic projections of water availability, both as to quantity and quality, and projections of related land resource availability, so as to outline the characteristics of projected water and related land resources problems and the general approaches that appear appropriate for their solution. Such framework studies would provide general guides to future water resource development. In addition to indicating which regions or subbasins have water problems calling for prompt detailed planning efforts as well as those where no such problems are current or looming, such studies will provide a substantial contribution of fact and analysis to subsequent detailed plan formulation.

Comprehensive Concept (Type 2 Studies) Studies of this type were made of the Willamette River Basin, Oregon, and Puget Sound and adjacent waters in Washington, the results of which are included in this document. They are more detailed studies of feasibility or survey scope for individual river basins, tributary basins, or subregions. They are used for areas with complex problems needing concerted multiagency action for their solution. For areas not previously covered by Type 1 studies, they encompass the features of the Type 1 study, plus the refinements and details of the feasibility or survey scope study. In cases where the Type 2 study area has been covered by Type 1 studies, pertinent features of the latter are summarized as needed for continuation into feasibility or survey scope studies. Type 2 studies are coordinated by a river basin commission or other Federal interagency-State coordinating organization. Such studies define or evaluate projects and programs in sufficient detail to comprise a basis for authorization or implementation of those projects to be initiated in the next 10 or 15 years.

Related Land The term "related land" as used in this study refers to land that is associated with water resources, or the effects of the water resources and their development features on the land. Only related land is involved directly in the formulation of framework plans. The study is not intended tc include all resources and their uses. Neither does the study cover such items as transportation systems or urban areas and industrial developments.

Projections As planning of water and related land resources is for the purpose of satisfying the future, the effort hinges on projections of future growth. To insure uniformity between projections and to relate all projections to the Nation as a whole, the Water Resources Council developed a national-interregional projections program which provided projections of population, income, employment, and the demand for agricultural and forestry goods and service both for the United States and for each region. Framework planning was based on these projections except for the Willamette and Puget Sound Subregions where independent projections were developed for Type 2 studies. These projections are summarized later in the text and in detail in Appendix VI, Economic Base & Projections.

These projected levels of population, economic activity, and agricultural productivity are only a representation of conditions that could exist in the future if past trends continued. They are indicators of potential problems and are not meant to be taken as goals or objectives or an assumption that past occurrence will continue into the indefinite future. Rather, the projections are used to formulate framework plans and alternatives as a baseline for further resource planning, protection, or development.

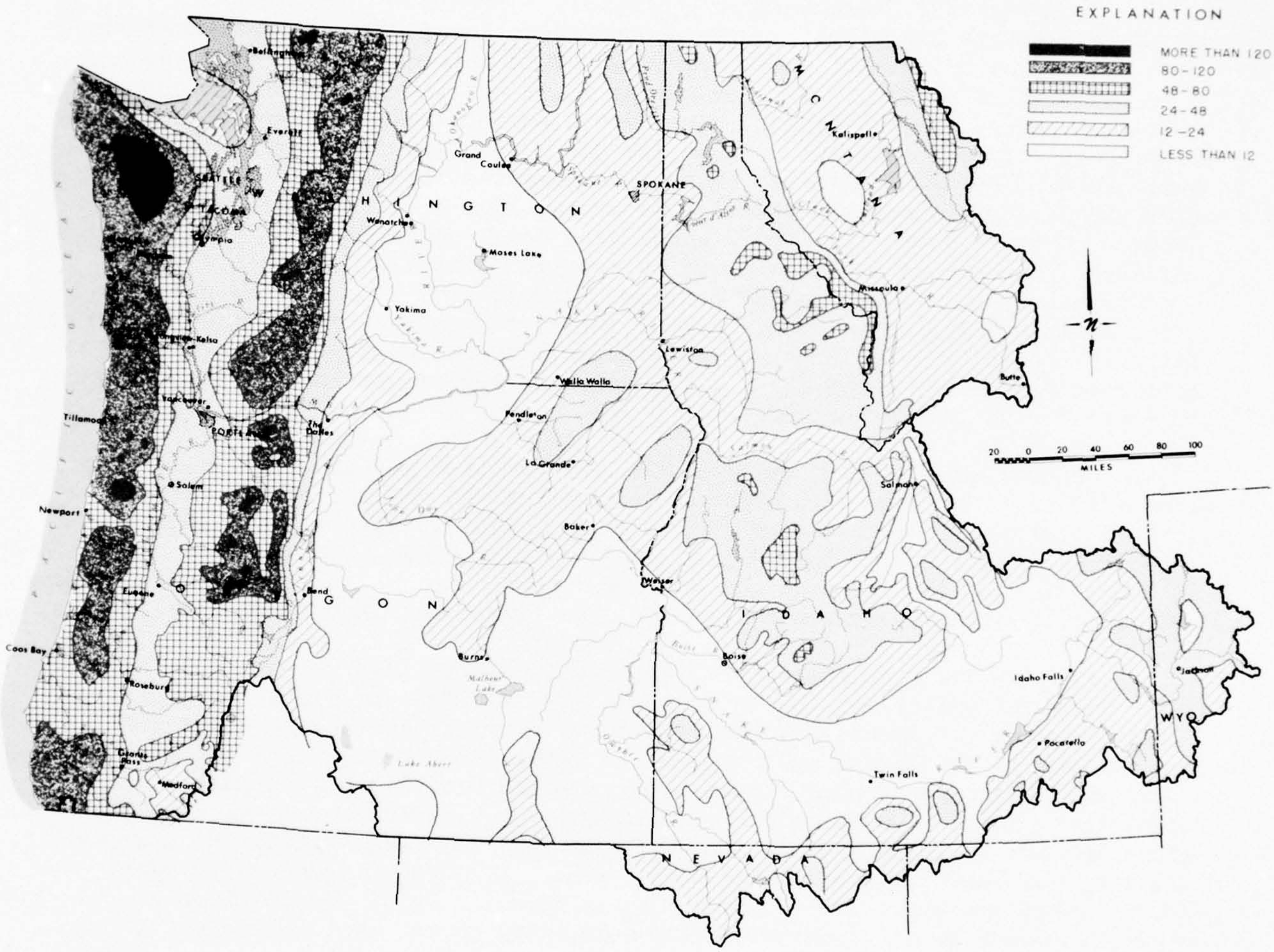


FIGURE 2. Mean Annual Precipitation in Inches

CLIMATE

Climatic conditions throughout the region reflect a diversity of land forms. The weather is largely a product of marine air masses moving inland from the North Pacific Ocean. These masses, which contain a great deal of water, release large amounts of moisture as they rise to pass over the western mountain ranges. Farther inland, as the marine air masses pass eastward beyond the mountain chains, they usually become moisture-absorbent, and the rainfall is so scanty that desert or semiarid climatic conditions prevail. Vegetation zones range from temperate rain forests and colorful mountain meadows to grey-green desert sage.

The areal and seasonal variation in average precipitation and temperature is exemplified by these data for Seattle on the coast and Boise in the interior.

		Seattle, Washington	*Boise, Idaho*
January	precipitation	5.2 inches	1.3 inches
	temperature	41.2°F.	29.1°F.
July	precipitation	0.6 inches	0.2 inches
	temperature	65.6°F.	75.2°F.
Annual	precipitation	34.1 inches	11.4 inches
	temperature	53.2°F.	51.0°F.

Figure 2 illustrates the regional pattern of mean annual precipitation.

The frost-free season typifies the generally moderate climate with 60 percent of the region containing a frost-free season of from 80 to 160 days a year. The range of frost-free days, however, is from over 240 days along the Pacific Coast to under 40 days along portions of the Continental Divide in eastern Idaho.

The Mission Valley in northwestern Montana (Mont. Highway Comm.).

LAND FORMS AND GEOLOGY

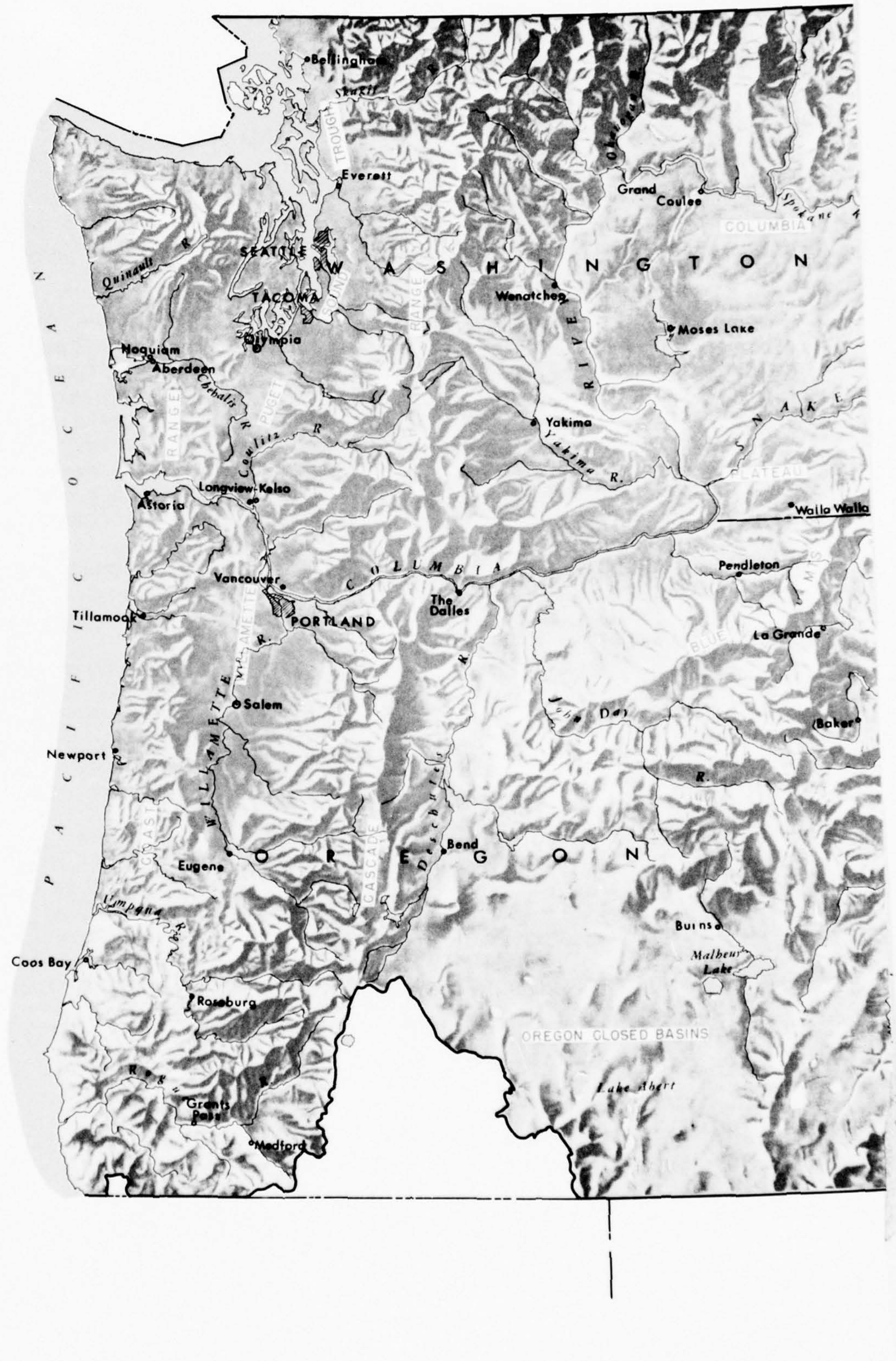
The landscape of the Pacific Northwest has a wealth of diversity. The viewer passes an endless array of features: snow-covered mountains, forested foothills, green valleys, rugged coastline, and sagebrush-covered desert, all of which compose the complex interwoven landscape.

The three major mountain ranges, the Coast Range, the Cascade Range, and the Rocky Mountains exhibit many diverse physical features. The peaks of the Coast Range, few of which extend over 3,000 feet, have thickly vegetated slopes of timber and underbrush. Inland and running parrallel to the Coast Range, the Cascades, a volcanic range with several peaks over 10,000 feet, have flanks which are covered by dense stands of timber. The Rocky Mountains are among the most impressive in the world with a few peaks over 12,000 feet; vegetation generally varies with elevation; grass and trees on the lower slopes transcend into forests which fade into bare rocks at timberline.

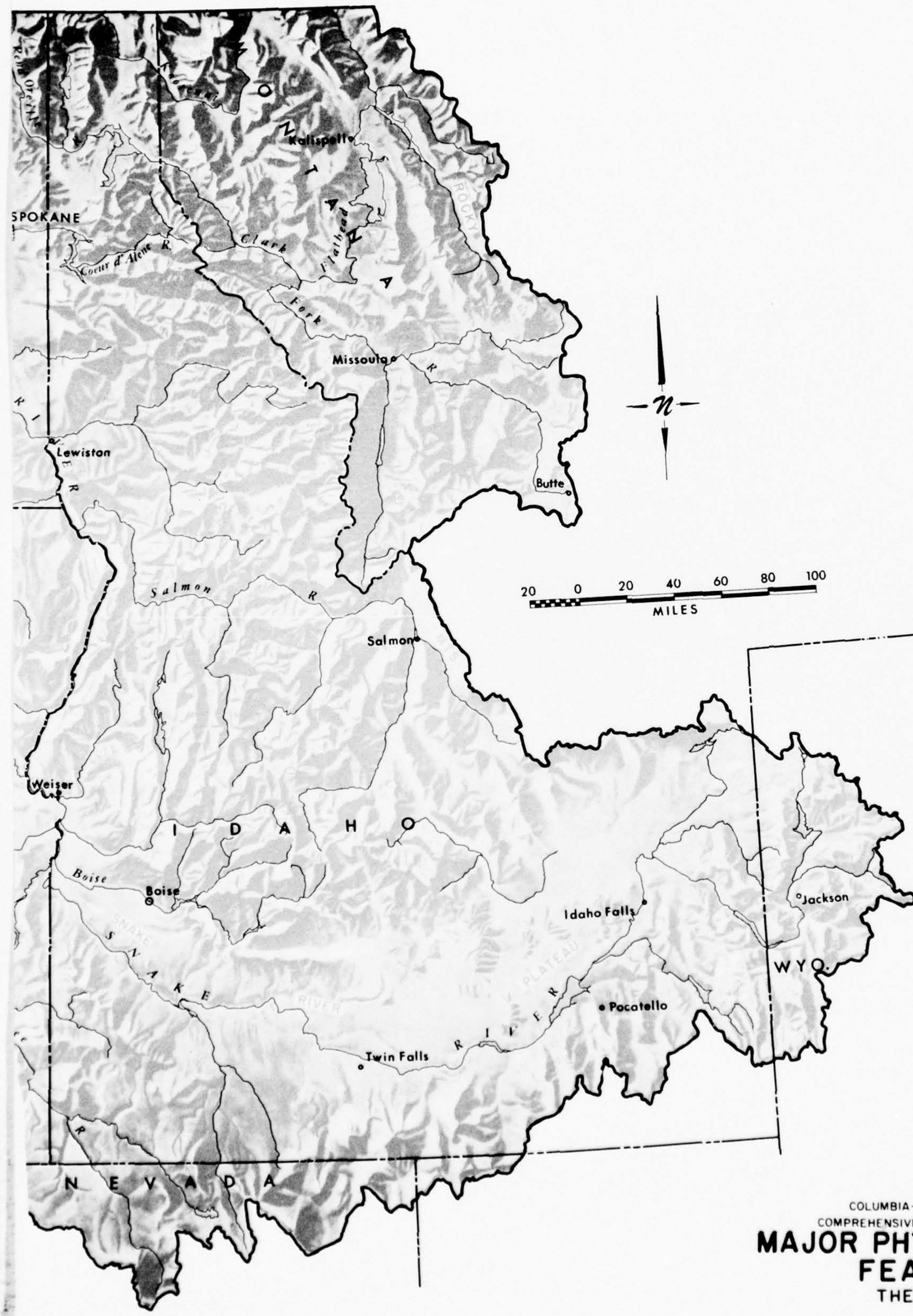
Between the Coast and Cascade Ranges lies the most extensive lowland section of the region, the Willamette-Puget Sound Trough. Although densely populated, it is interspersed with forest, brush, and grassland.

Most of eastern Oregon and Washington, and southern Idaho, are contained in a large upland which is commonly called the Columbia Plateau. The plateau is divided into several sections and subsections but, in general, these exhibit similar geological and vegetative features. The surface is almost entirely of volcanic origin covered with a soil mantle of varying depth; where undeveloped dryland plants such as sagebrush, grass, and juniper are found.

The geologic structure, broadly characterized, consists of sedimentary and metamorphic rocks of the Rocky Mountains in the northern and eastern sections, and igneous rocks of the Cascades and the Columbia Plateau in the western, southern, and central portions. The Rocky Mountains, which were formed by extensive folding and thrust-faulting, are a series of metamorphic and sedimentary rocks consisting of quartzites, limestones, argillites, and shales. Glacial action has profoundly altered the valleys of the northern and eastern sections, and extensive glacial deposits remain in certain sections. The Columbia Plateau was formed by a series of lava flows extending from the Rocky Mountains to the Cascades and from the Okanogan Mountains to beyond the southern portion of the Columbia River Basin (figure 3).



Bellingham
Skagit R.
TROUGH
Everett
SEATTLE
TACOMA
Olympia
W A S H I N G T O N
Grand
Coulee
COLUMBIA
Spokane R.
Okanogan R.
Wenatchee
Moses Lake
RIVER
RANGE
Quinault R.
Hoquiam
Aberdeen
Chehalis R.
PUGET
RANGE
Cowlitz R.
Yakima
Yakima R.
S N A K E
PLATEAU
Walla Walla
Longview-Kelso
Astoria
P A C I F I C O C E A N
Vancouver
C O L U M B I A
The Dalles
Pendleton
Tillamook
PORTLAND
WILLAMETTE
R.
BLUE
La Grande
Salem
John Day
R.
Baker
Newport
WILLAMETTE
Deschutes
Bend
O R E G O N
COAST
CASCADE
Eugene
Umpqua R.
Coos Bay
Burns
Malheur Lake
Roseburg
OREGON CLOSED BASINS
Lake Abert
Rogue R.
Grants Pass
Medford



COLUMBIA - NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

MAJOR PHYSIOGRAPHIC FEATURES

THE REGION

1968

FIGURE 3

The Hells Canyon—Seven Devils Scenic Area. Hells Canyon has the distinction of being the deepest gorge in the United States (USFS).

Mountains either dominate or constitute the background for every landscape. In sharp contrast to the mountains are the lowlands of the Willamette-Puget Sound Trough, the broad plains along the Snake River, interior valleys, the Pacific Ocean, with a coastline of sandy beaches, coves, and rugged headlands; and the high, dry desert plateaus east of the Cascades. Erosion, glaciation, and volcanism are illustrated by gorges and canyons of the Columbia and Snake Rivers, and Crater Lake.

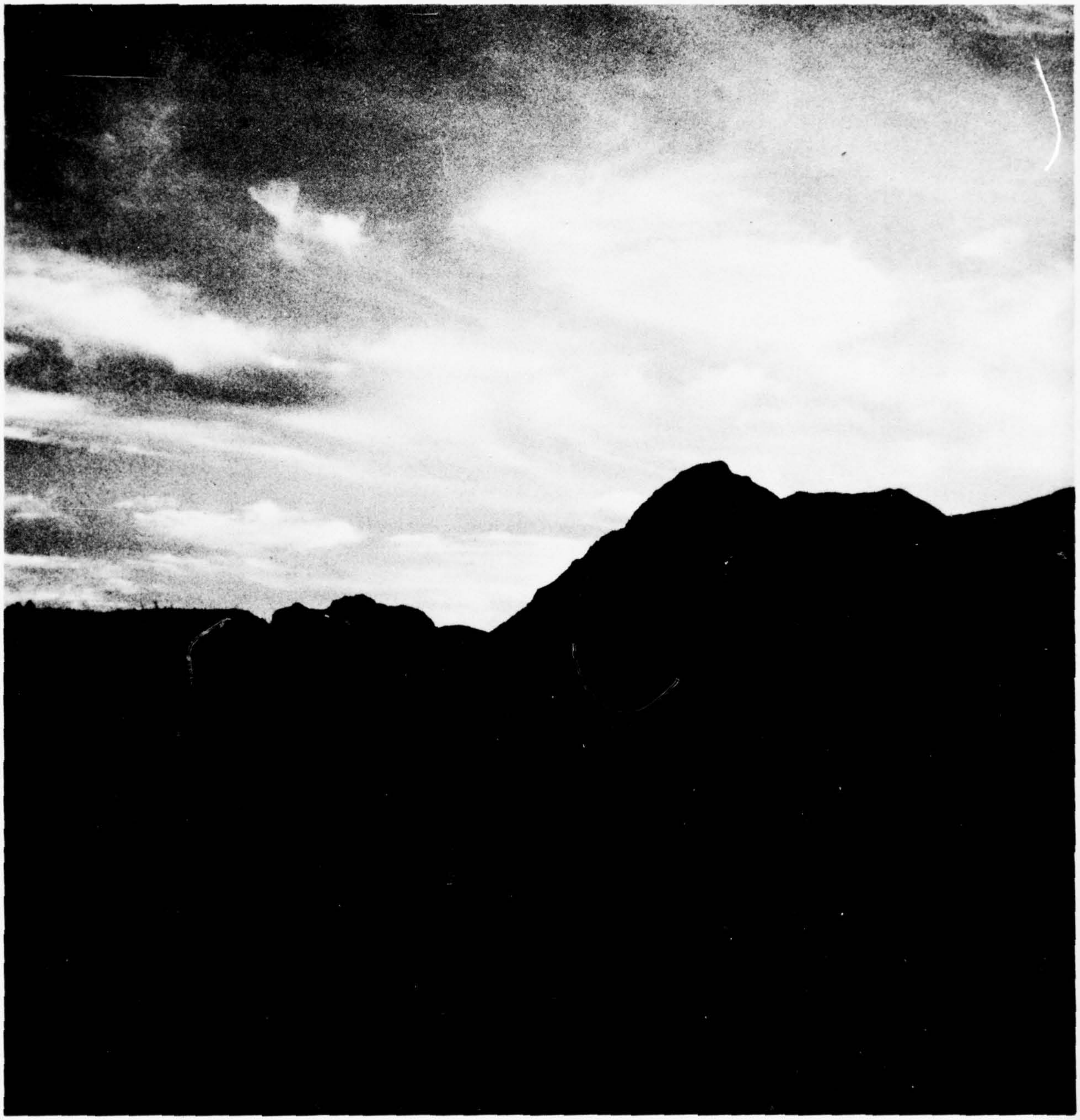
The Columbia River and its tributaries dominate the water scene. The main stem rises in a mountain lake on the west slope of the Canadian Rockies, 2,650 feet above sea level and flows northwestward through one of the trenches which marks the northern Rocky Mountain system, cuts through to an adjacent trench, and then courses southward. After entering the United States near the northeastern corner of Washington, the Columbia crosses that state in a southerly trending series of big bends, then takes its final westward course to the ocean through a gorge which bisects the Cascade Range. The scenic quality of this gorge is unique; the elevation of the Columbia River is less than 100 feet, yet the shoreline bluffs culiminate in three mountain peaks of 10,000 feet or more located within 40 miles in any of three directions.

The Columbia's major tributary, the Snake River, is about 1,000 miles long and drains about 110,000 square miles, or approximately half the United States' portion of the Columbia River Basin. The lower-central portion of this river flows in a northerly direction forming the Oregon-Idaho boundary for many miles. This reach cuts through rugged mountain terrain in the famed Hells Canyon which has the distinction of being the deepest gorge in the United States.

Other streams discharging into the Pacific Ocean in Washington and Oregon and those emptying into Puget Sound are small in comparison with the Columbia. Considering the size of their drainage basins, however, they have high annual flows.

The abundant fish and wildlife resources of the region are composed of anadromous fish, resident fish, marine fish, and shellfish, big game, upland game, fur animals, waterfowl, and other wildlife which are significant to man's enjoyment and to the economy. Hatchery fish are stocked in streams, lakes, and reservoirs. Wildlife is protected and managed on 71 refuges and management areas. These areas provide public hunting and opportunities to see and photograph more than one million birds and other animals in their natural habitat.

The Northwest has 41 national forests and grasslands covering 54.4 million acres. Recreation is emphasized in the administration of the national forests where numerous campsites, picnic grounds, and sanitary facilities have



Summer sunset at Glacier National Park (USCE).

been established for public use. A network of trails appealing to the hiker is maintained, and of chief importance is the Pacific Crest Trail System stretching from Canada to Mexico. Routed along the crest of the Cascades, it leads to many points of scenic beauty accessible only by packhorse or foot.

The region contains seven National Parks and parts of two others, three national recreation areas, and five historical areas. In addition, some 54 sites in the region have been declared eligible for registration as National Landmarks.

Recreation is encouraged on much of the 29.5 million acres under jurisdiction of the Bureau of Land Management, but lack of development, access, and public awareness has limited the use primarily to sightseeing, hunting, and fishing. In 1968, BLM administered 81 developed recreation sites in the Northwest, many of which offer water-related recreation opportunities.

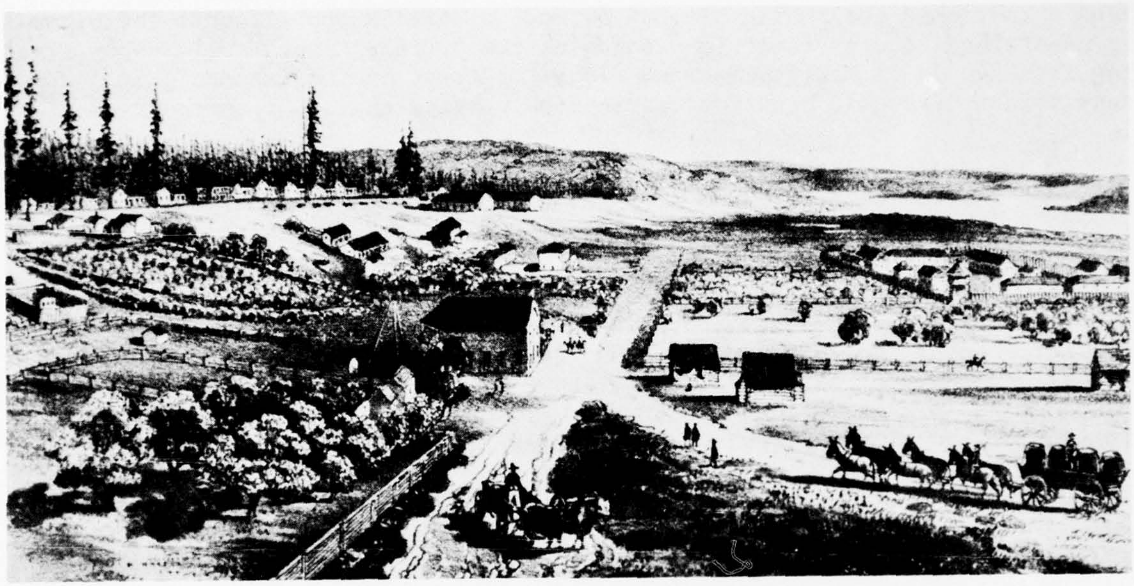
The Northwest States administer 376 recreation areas, 90 percent of them scattered through Oregon and Washington. Oregon has the distinction of having the greatest number (210) of state parks in the Nation. State highway maintenance departments have established a series of attractive picnic spots along principal roads. The State of Washington has developed 18 well-chosen marine parks, chiefly on Puget Sound and maintains 35 historical or geological sites. Notable are Gingko Petrified Forest, Sacajawea, and Fort Columbia.

Past and present activities of man contribute to the natural landscape and furnish interesting and stimulating recreation outlets. Dams, bridges, and other structures represent skillful engineering feats; logging and milling operations, mining and commercial fishing activities, and industrial plants are interesting additions. Seas of wheat, orchards, brilliant fields of flowering bulbs, irrigated crops, beef cattle, sheep, and dairying form the agricultural setting.

HISTORICAL BACKGROUND

Up to the time that the first white explorer arrived in the Pacific Northwest no form of agriculture had been developed. Food supplies of the natives were obtained by hunting, fishing, and the gathering of natural flora of the region.

The first Europeans to visit the region were the Spanish who began their exploration in 1542. During the next 50 years, they made several trips along the coast, after which exploration essentially ceased for nearly two centuries. Spanish exploration began again in 1774 and in 1778 the English began active exploration and fur trading. In 1787, American merchants sent two ships to the Pacific Northwest under Captains Gray and Kendrick; on his second voyage,



Fort Vancouver from the Northwest, 1854, drawn by Gustavus Sohon. From U. S. War Department, Reports of Explorations and Surveys, to "Ascertain the most practicable and Economic Route for a Railroad from the Mississippi River to the Pacific Ocean," vol. XII, Plate XLIV (NPS).

Gray discovered the Columbia River. Because of the distance from population centers, overland exploration did not start in earnest until the Lewis and Clark Expedition of 1804-1806.

The first non-Indians were employed by trading companies. They built several forts which became the nucleus for settlement by providing security, trade goods, livestock, seed, and many other basic elements. Trappers and farmers were soon followed by missionaries, doctors, merchants, and other interests.

In 1846 when the United States and England agreed upon the 49th parallel as the boundary between Canada and the United States, there were less than 6,000 non-Indians in the region; 4 years later there were about 13,000, concentrated in the Willamette Valley-Vancouver area.

By the mid-1850's, overland routes were well developed and settlers started pouring in, occupying the best farmland, starting towns, and establishing local government. Oregon attained statehood in 1859; Washington and Montana in 1889; Idaho and Wyoming in 1890. By 1870, the non-Indian population of the region was 135,000, with 91,000 in Oregon and 24,000 in Washington.

To encourage settlement and to develop transportation routes, several railroad land grants were made in the 1860's and 1870's. In the Pacific Northwest, these grants totaled approximately 14 million acres. The lands were generally sold to settlers at rates comparable to those received for the public domain. The railroads were constructed between the 1860's and 1900's and brought a new surge of settlers. By 1900, the total population was approximately 1.2 million people, and by 1910 it was over 2.2 million people.

The population growth leveled off from 1910 to 1920; however, after 1920, there was a resumption of the rapid growth rate. In 1930, the population had reached 3.1 million.

When a regionwide inventory was made in 1934, there were an estimated 14.4 million acres of cropland and nearly 29 million acres of privately owned grazing land.

Settlement patterns changed somewhat during the early 1930's in part because of government projects. Dams and irrigation projects created new agricultural developments and towns. Population increased in all the states, especially in Idaho and western Montana, and by 1940 totaled 3.5 million.

The second World War also brought many changes. Wartime industries located here because of the large blocks of electric power readily available. Shipbuilding and aircraft construction became important almost overnight, attracting thousands of people from farms and other sections of the country. Urban growth continued as more and more industries located here. Some industries suffered a sharp decline after the war was over. Most, however, stabilized after a few years and formed the bases for continued regional growth.

Population became more concentrated in the cities. By 1960, the region's population was about 5.4 million, or an increase of 18 percent since 1950. Urban population comprised about 63 percent of the total, with 2.2 million living in the Seattle-Tacoma and Portland-Vancouver metropolitan areas. There were an estimated 5.9 million residents in 1965, with only Idaho and western Montana considered primarily rural.

In 1970 the population of the region was 6,373,600. The population density varied from 142 persons per square mile in the Puget Sound Subregion to 0.7 persons per square mile in the Oregon Closed Basin.

Figure 4 shows the approximate growth of population over the past 170 years.

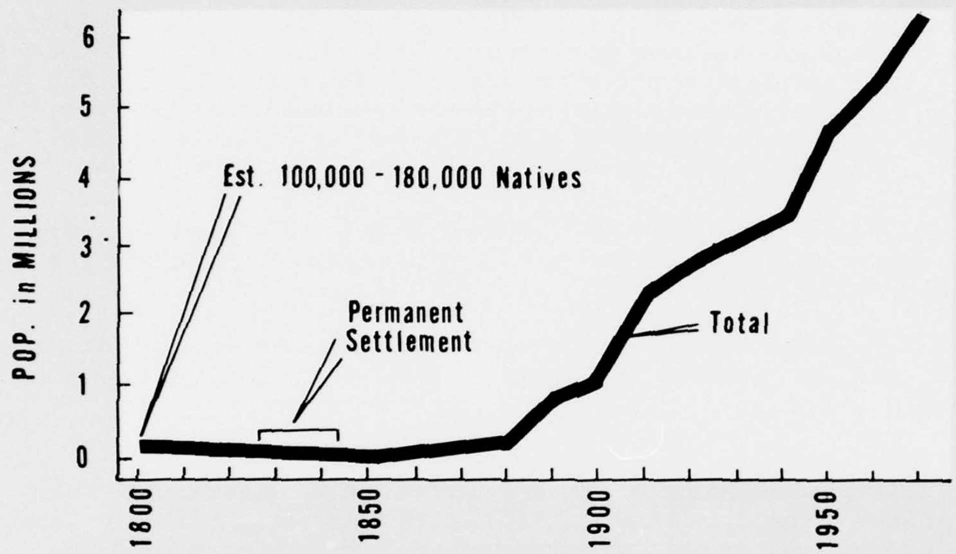


FIGURE 4. Population Trend in the Columbia-North Pacific Region. Extracted from: Census of Population 1950 & 1960.

The seven standard metropolitan statistical areas in the Pacific Northwest had 1970 populations of:

Seattle-Everett	1,421,869
Portland-Vancouver	1,009,129
Tacoma	411,027
Spokane	287,487
Eugene Springfield	213,358
Salem	186,658
Boise	112,230

The major industries are: agriculture and food processing, lumbering and forest products, recreation, minerals, metals, chemicals, and manufacturing. The two most important industries in terms of number of persons employed and economic effect are agricultural and forest products. In 1965, the forest industry employed nearly 166,000 people or over one-third of the total manufacturing force. Agricultural employment in 1960 was 156,000 people but is continually decreasing. Total employment in the region was nearly 2.5 million in 1970.

Table 1—Summary of Water and Land Resources, 1970
Columbia-North Pacific Region

	Water						Land		
		Mean	Mean		Ground Water 4/				
Subregion	Surface Area 3/	Annual Inflow 1/	Annual Outflow 1/	Storage Volume 2/	Volume	Recharge	Surface Area 3/	Arable 5/	Irrigable 6/
	1,000 ac	cfs	cfs	1,000 ac-ft	1,000 ac-ft	1,000 ac-ft	1,000 ac	1,000 ac	1,000 ac
1	452	12,305	48,558	11,479	69,000	19,000	22,819	5,055	2,990
2	288	109,500	114,100	7,578	35,000	6,000	14,081	4,790	3,701
3	29	0	3,240	1,071	13,000	2,000	3,851	1,463	1,137
4	266	0	8,590	5,417	100,000	18,000	22,682	7,027	6,948
5	170	8,590	16,338	4,599	100,000	5,000	23,398	6,668	6,521
6	81	16,338	45,984	1,631	31,000	9,000	22,371	4,458	3,667
7	126	163,531	177,400	1,814	47,000	12,000	18,822	8,187	6,267
8	73	210,437	235,408	2,201	8,000	6,300	3,193	1,130	577
9	106	0	38,490	2,017	27,000	11,000	7,603	2,802	1,747
10	155	0	87,615	169	27,000	16,000	15,054	3,567	1,705
11	100	977	53,090	2,426	40,000	11,000	8,447	2,067	1,611
12	63	0	1,650	17	56,000	800	11,395	3,850	3,261
Region	1,909	74,230	384,008	40,419	553,000	116,100	173,716	51,064	40,232

1/ From Appendix V, Water Resources.
2/ Reservoirs over 5,000 acre-feet only active capacity shown, source Appendix V, Water Resources.
3/ From Appendix IV, Land and Water Areas tables (rounded).
4/ Gross values from storage, recharge, and discharge of ground water in aquifer units, Appendix V.
5/ Sum of Land Capability Class I through IV and Class VI suitable for crops.
6/ Dry irrigable and irrigated land, Appendix IX (includes land presently irrigated).

Basic resources found in abundance in the Columbia-North Pacific Region are high quality water and land, as well as some minerals in sufficient quantities to be of economic importance. Land and water resources are summarized in table 1. Fish, wildlife, and timber are important resource products. The principal limitation on the use of these resources is their distribution.

SURFACE WATER

Although water is abundant on an annual basis, most precipitation occurs during the winter resulting in a deficiency during the summer months, especially in the central and eastern parts. Other limiting factors are economic, political, and social.

Quantity

Available surface water averages 278 million acre-feet annually, which is equivalent to an annual discharge of 384,000 cfs. Of this amount, some 54 million acre-feet, or 74,000 cfs, are inflow from Canada and 224 million acre-feet or 310,000 cfs originate within the region.

The Columbia River and its tributaries constitute the major stream system draining the region. The volume of flow of the Columbia River is exceeded in the contiguous United States only by that of the Missouri-Mississippi river system. Excluding the Canadian part, the Columbia River drainage basin contains 219,392 square miles or 80 percent of the region's total drainage area and discharges an average of 168,850 cfs or 54.5 percent of the water in the region. The Canadian contribution to the Columbia River is about 73,000 cfs from 39,500 square miles of drainage area. Subregion 12 is the only part of the region lying east of the Cascade Range that is not tributary to the Columbia River Basin. Even though that subregion represents 6.5 percent of the region's area, it contributes less than 1 percent of the water. The Puget Sound and coastal subregions include 13.5 percent of the area but contribute 45 percent of the water. Geographic differences in mean annual runoff are shown in figure 5.

The average discharge for each state, subregion, and the region for the base period 1929-58 adjusted to reflect 1970 levels of utilization are shown in table 2. The discharge for a subregion represents the flow originating in that subregion or outflow minus inflow. The inflow from Canada is added to complete the water availability picture.

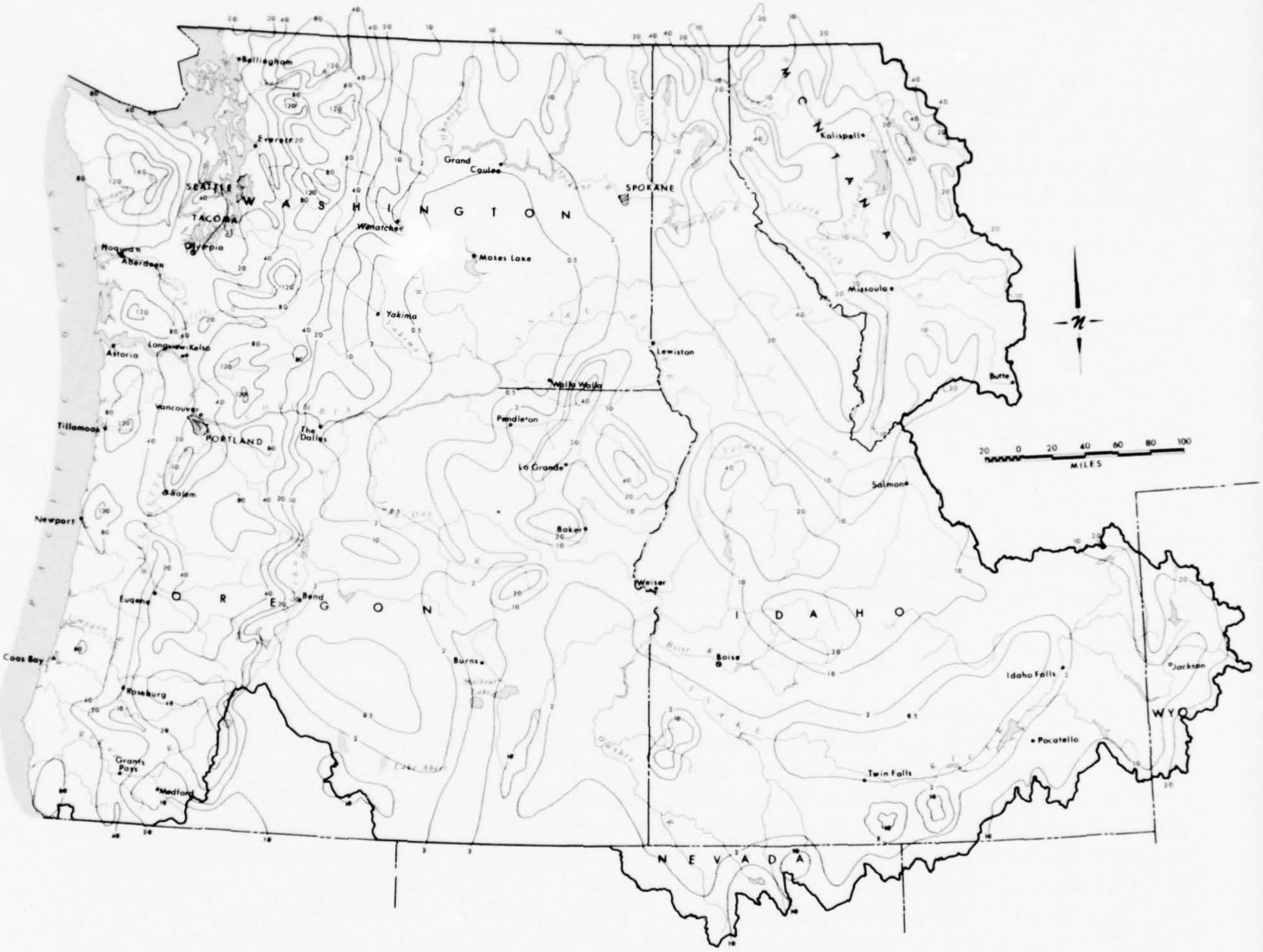

WASHINGTON
OREGON
IDAHO
MONTANA
NEVADA
WYO
Bellingham
Everett
SEATTLE
TACOMA
Olympia
Hoquiam
Aberdeen
Astoria
Longview-Kelso
Tillamook
Vancouver
PORTLAND
Salem
Newport
Eugene
Coos Bay
Roseburg
Grants Pass
Medford
Grand Coulee
Wenatchee
Moses Lake
Yakima
The Dalles
Bend
SPOKANE
Lewiston
Walla Walla
Pendleton
La Grande
Baker
Burns
Weiser
Boise
Kalispell
Missoula
Butte
Salmon
Idaho Falls
Pocatello
Twin Falls
Jackson
20 0 20 40 60 80 100
MILES

Table 2—Annual Discharge, Base Period 1929-58, 1970 Conditions
Columbia-North Pacific Region

			(cfs)		Average Annual Discharge			(cfs)	
Subregion	Area (Sq. Mi.)	Total	Idaho	Montana	Nevada	Oregon	Utah	Washington	Wyoming
1	36,361	36,253	11,328	22,350	-	-	-	2,575	-
2	22,451	5,300	-	-	-	-	-	5,300	-
3	6,062	3,240	-	-	-	-	-	3,240	-
4	35,857	8,590	1,843	-	138	-	28	-	6,581
5	36,825	7,748	5,761	-	772	1,215	-	-	-
6	35,081	29,939	26,300	-	-	3,400	-	239	-
7	29,606	13,869	-	-	-	9,260	-	4,609	-
8	5,103	24,971	-	-	-	-	-	24,971	-
9	12,046	38,490	-	-	-	38,490	-	-	-
10	23,763	87,615	-	-	-	52,919	-	34,696	-
11	13,355	52,113	-	-	-	-	-	52,113	-
12	17,904	1,650	-	-	-	1,650	-	-	-
U. S. Total	274,414	309,778	45,232	22,350	910	106,934	28	127,743	6,581
Canada	39,910	74,230							
TOTAL	314,324	384,008							

Detailed streamflow data were developed for 169 selected sites. These sites, averaging 14 per subregion, are considered representative and include many gaging stations where long-term records have been collected. Data for 34 of these sites are summarized in table 3.

In spite of the apparent large total supply, water is not always available where and when it is needed. Extreme variations occur in both the areal distribution and timing of runoff; consequently the average discharge is not the usable supply. Even with storage, the total mean discharge is not usable because of natural losses and seasonal as well as year-to-year variations. In most streams, the minimum year of discharge provided only about 60 percent of the average annual flow; also, the mean of the minimum 5 consecutive years supplied only about 75 percent of average. There are some large streams that produce minimum year flows as low as 25 percent of the long-term average.

Table 3—Streamflow Summary for Selected Sites
Columbia-North Pacific Region

Subregion	Stream	Station	Drainage Area (sq. mi.)	Annual Flow 1/ Mean (cfs)	Max.	80% Flow	Min.	Momentary Flow 2/ Max. (cfs)	Min.
1	Kootenai	Porthill	13,700	15,328	22,143	10,722	9,926	125,000	1,380
1	Pend Oreille	Z-Canyon	25,200	25,839	37,624	17,902	14,861	171,300	2,500
1	Spokane	Spokane	4,290	6,485	10,353	3,923	2,970	49,000	95
1	Clark Fork	Plains	19,958	18,328	26,253	12,697	9,954	134,010	3,200
2	Columbia	Priest Rapids	96,000	114,100	159,000	89,900	86,600	692,600	4,120
2	Okanogan	Tonasket	7,280	2,894	4,588	1,785	1,241	40,900	126
2	Wenatchee	Peshastin	1,000	3,010	5,386	1,888	1,729	32,300	183
3	Yakima	Kiona	5,615	3,240	6,843	1,766	1,540	67,000	105
4	Snake	King Hill	35,800	8,590	11,999	7,044	6,909	47,200	1,250
4	Henrys Fork	Rexburg	2,920	1,512	2,387	1,034	798	11,000	183
5	Snake	Oxbow	73,150	16,338	26,037	12,349	11,124	76,800	441
5	Boise	Notus	3,820	960	2,325	410	289	20,500	10
5	Payette	Payette	3,240	2,707	4,521	3,722	1,430	30,900	180
6	Snake	Ice Harbor Dam	108,500	45,984	66,398	35,220	31,029	298,000	11,800
6	Salmon	Whitebird	13,550	10,690	15,891	7,563	5,792	106,000	1,580
6	Clearwater	Spalding	9,570	14,573	22,447	10,599	9,826	177,000	500
7	John Day	McDonald Ferry	7,580	1,925	3,669	982	630	42,800	4
7	Deschutes	Moody	10,500	5,186	7,340	4,097	3,940	75,500	2,400
7	Columbia	Bonneville	240,000	177,400	247,346	142,517	131,353	1,240,000	35,000
8	Lewis	Ariel	731	4,752	7,069	2,298	3,090	129,000	1
8	Cowlitz	Castle Rock	2,238	8,932	12,484	5,893	5,776	139,000	998
8	Columbia	Mouth	259,000	239,671	388,362	185,228	165,611		
9	McKenzie	Coburg	1,337	5,508	8,242	3,361	3,170	88,200	1,250
9	Santiam	Jefferson	1,790	7,596	11,722	4,441	4,656	197,000	260
9	Willamette	Oregon City	10,008	29,900	43,694	16,480	17,660		
10	Rogue	Gold Beach	5,060	11,290	21,150	5,252	4,621		
10	Umpqua	Elkton	3,683	7,353	13,350	3,925	3,150	256,000	640
10	Chehalis	Grand Mound	895	2,761	4,444	1,540	1,569	48,400	90
10	Quinalt	Quinalt Lake	264	2,766	3,571	1,842	1,780	50,200	276
11	Puyallup	Puyallup	948	3,292	4,927	2,356	2,087	57,000	400
11	Snoqualmie	Carnation	603	3,714	5,190	2,410	2,314	59,500	239
11	Sauk	Sauk	714	4,241	5,923	2,950	2,887	82,400	572
11	Skagit	Concrete	2,737	14,224	20,003	10,421	9,507	500,000	2,160
12	Chewaucan	Paisley	275	139	341	32	32	6,490	0
12	Silvies	Burns	934	164	375	44	15	4,960	0

1/ Regulated values for base period (1929-1958) 1970 conditions.
2/ Observed values for period of record.
Source: Appendix V, Water Resources.

Quality

Although the quality of surface waters is generally good for most uses, most supplies require treatment before being used for domestic purposes. Treatment is not required for irrigation or for most industrial uses.

Most of the water in the region is chemically suitable for domestic use. Generally surface water is soft to moderately hard with a dissolved solids content usually less than 250 mg/l with only a few small areas exceeding 1,000 mg/l. The streams in the mountainous parts of the region mostly have a dissolved solids content of less than 100 mg/l, and some have less than 50 mg/l. Streams that have a dissolved solids content of more than 1,000 mg/l are the Malheur and Owyhee Rivers in eastern Oregon and the Raft River in southern Idaho. The dissolved solids content of water in lakes with no outlets ranges from 1,000 to 70,000 mg/l or more.

Salt-water intrusion into the Columbia River estuary reaches about 23 miles upstream from the mouth. For most streams adjacent to saline water, the extent and degree of salt-water intrusion are not accurately known.

The requirements of the salmonid fishery govern the necessary level of dissolved oxygen for most water courses. Standards for dissolved oxygen levels normally range from 5 mg/l for fish passage needs up to saturation for waters used for spawning and rearing purposes. Values below 5 mg/l are considered detrimental to fish life, and values below 3 mg/l extremely harmful to aquatic life. Low dissolved oxygen concentration occurring in a number of stream reaches normally is the result of heavy biochemical oxygen demand exerted by municipal, pulp and paper, or food processing wastes. For example, critical oxygen problems exist seasonally in the Spokane River at and below Long Lake, in portions of the Snake River, and in the lower reaches of the Boise, Duwamish, Chehalis, South Santiam, and Tualatin Rivers. In recent years, values below 3.0 mg/l have been observed in the Spokane River at Long Lake and below 2.0 mg/l in Duwamish River near Seattle.

Most streams can be used for swimming, boating, fishing, and other recreational uses with little hazard from pathogenic (disease-producing) bacteria. In reaches where pathogenic bacteria are a problem, bacteriological quality usually shows very marked and abrupt changes, primarily as a function of sewage disposal.

Major streams with known occurrences of serious bacteriological pollution (maximum mpn values greater than 10,000 coliform bacteria per milliliter) are: Snake River upstream from Payette, Idaho; Clark Fork River below Missoula, Montana; Spokane River downstream from Coeur d'Alene, Idaho; Yakima River downstream from Ellensburg, Washington; Willamette River downstream from Ellensburg, Washington; Willamette River downstream from Eugene, Oregon; Columbia River downstream from Portland, Oregon; and near the mouths of several of the larger streams entering the east and south sides of Puget Sound. Bacterial

pollution in these streams is not always at such high levels; during most of the year, streamflow is sufficient to dilute discharged sewage to a much lower level. Maximum values generally occur during the dry summer months when streamflow is low.

Nutrients, such as nitrate and phosphate, originating from both natural and manmade sources, are the major cause of excessive aquatic growths in parts of the region such as the Yakima and Snake Basins and areas of the Columbia Basin Irrigation Project. In addition to causing taste and odor problems, such growths increase maintenance costs to irrigators by clogging diversion and distribution structures. Intensive algal growths cause extreme diurnal fluctuations in dissolved oxygen concentrations in some streams and in reservoirs such as Brownlee. A recent fish kill in American Falls Reservoir has been attributed to low dissolved oxygen concentrations resulting from decomposition of dead algal cells. Other nutrients, derived principally from pulp and paper wastes, have contributed to the periodic slime problem in the lower Columbia River.

Some streams have been rendered biologically sterile and nonproductive because of mine wastes. This type of problem occurs in reaches of streams such as the South Fork Coeur d'Alene, Pend Oreille, and Clark Fork Rivers.

Sediment yield of lands east of the Cascade Range varies from 0.02 to 4.0 acre-feet per square mile per year, with more than one-half the area in the range of 0.02 to 0.1 acre-foot per square mile per year. Only a few rather small areas yield more than 0.5 acre-foot per square mile per year. On the west side of the Cascade Range, most of the area lies in the 0.1 to 0.2 acre-foot per square mile per year range, with only small local areas ranging up to 0.5 or down to 0.02 acre-foot per square mile per year. The areas of greatest sediment yield in the region are the windblown soil areas in the Palouse and Walla Walla River Basins of southeastern Washington. Sediment concentrations as high as 383,000 mg/l have been measured in the high yield area near Walla Walla, Washington. There is a considerable range in the quantity of fluvial sediment transported by the other streams in the region.

GROUND WATER

The region contains roughly 550 million acre-feet of ground water within the top 50 to 100 feet of the water-bearing strata. Not only are large quantities of water obtained from wells and springs, but also a large part of surface-water supply is maintained by discharge from aquifers, especially during prolonged periods of dry weather when the flow of many streams is mostly or

entirely composed of ground-water effluent. Only in coastal areas does any significant quantity of ground water leave the subregion that does not appear as a component of stream discharge. Elsewhere, ground-water use does not add to the total available supply except to the extent that ground-water withdrawals reduce evapotranspiration losses. However, it does offer great opportunities for management by augmenting minimum flows and increasing firm supplies by drawing water from underground storage during dry periods and replacing the ground water by natural or artificial recharge during periods of excess rainfall and runoff.

About 42 percent of the region is underlain by aquifer units with low porosity and permeability that generally yield only small supplies of ground water.

There are probably few unknown aquifers, but knowledge about every one is incomplete, and for some it is very sketchy, particularly in the more arid parts of Idaho, Oregon, and Nevada. The geologic mapping in much of those areas has only been of a reconnaissance type. Detailed ground-water investigations have been made in about 10 percent of the region. The estimated distribution of ground-water resources by aquifer units is summarized in table 4.

The source of recharge is precipitation which reaches aquifers in a variety of ways depending on such factors as the amount and rate of precipitation, the character of the aquifer and overlying material, the pattern and spacing of surface drainage, and the slope of the terrain. Gross annual recharge is estimated to be 120 million acre-feet annually. However, some of the water moves from surface to ground water two or three times in its travel so that the net annual recharge is probably on the order of 100 million acre-feet.

The quality of ground water generally ranges from good to excellent for most uses. Water from alluvial deposits and volcanic rocks west of the Cascade Range and in the humid areas east of the Cascade Range usually has less than 300 mg/l dissolved solids. The water ranges from soft to hard (from less than 60 mg/l to more than 120 mg/l). In the arid and semiarid areas, the ground water has slightly higher concentrations of dissolved solids than in the humid areas, but still is generally less than 500 mg/l, except in the Oregon Closed Basin where concentrations of 500 to 1,000 mg/l are fairly common.

Table 4—Summary of Storage, Recharge, and Discharge of Ground Water in Aquifer-unit Groups
Columbia-North Pacific Region

Aquifer-unit Group	Area: Square Miles (thousands)	Area: Acres (millions)	Quantity of Water in Storage (millions of ac-ft)	Gross Annual Natural Recharge and Natural and Pumped Discharge (millions of ac-ft)
1. Alluvial and Glacial Deposits	41.3	26.5	270	36
2. Younger Volcanic Rocks	28.9	18.5	80	28
3. Younger Sedimentary Rocks	16.1	10.3	80	2
4. Silicic Volcanic Rocks	7.7	4.9	10	1
5. Volcanic Rocks of Middle Tertiary Age	58.0	37.2	38	10
2-5. Volcanic and Sedimentary Rocks, Undifferentiated	5.5	3.5	18	0.5
6. Older Volcanic Rocks	13.5	8.6	8	7
7. Older Sedimentary Rocks	11.4	7.3	4	6
8. Older Volcanic and Sedimentary Rocks	6.5	4.2	3	1
9. Pre-Tertiary Rocks, Undifferentiated	82.3	52.6	47	29
Total	271.2	173.6	558	120.5

Source: Appendix V, Water Resources.

LAND

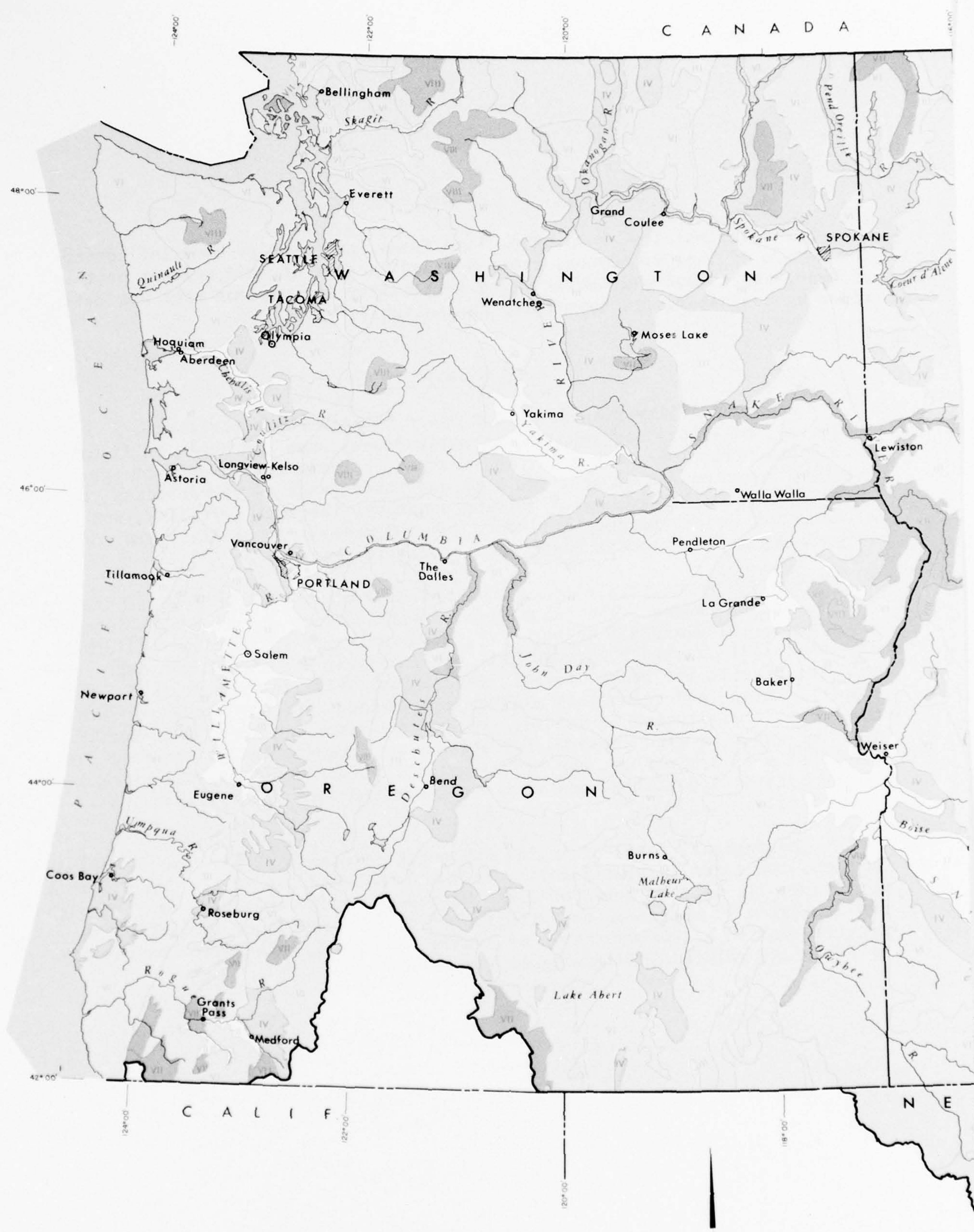
The variability of climate, land forms, and geology have influenced the nature of land resources, their use and management, and current pattern of ownership. Land availability and suitability for various uses was determined by evaluating its capability and suitability.

Land Capability

Land capability classification based on soil characteristics, qualities, behavior, and response to agricultural uses are shown on figure 6. Soil characteristics (such as depth, texture, structure, presence of aggregate, wetness, reaction and slope), and soil qualities (such as permeability, erosion hazard, overflow hazard, water-holding capacity, inherent fertility, and climatic conditions as they influence use and management of land) are considered in grouping soils into the eight land capability classes.

Table 5 summarizes acreages by land capability classes for each subregion and the region. The capability classifications can be broken into two divisions: (1) Classes I through IV are suitable for cultivation and other use, while (2) Classes V through VIII are generally unsuitable for cultivation but are suitable for range, forest, recreation, wildlife habitat, and water supply. These land capability classes are divided into subclasses to indicate the dominate limitation or hazard. These subclasses, in order of priority, are: "e" water or wind erosion, "w" wetness or frequent inundation from overflow, "s" soil limitation, and "c" climatic limitation. This interpretation of the hazards and limitations in the use of land does not evaluate its productivity.

The regional total of 36,164,000 acres in Classes I through IV includes 20.8 million acres currently cultivated, plus potentially arable lands. This total, plus 15 million acres of Class VI desert lands in Subregions 1 through 7 and Subregion 12 estimated to be suitable for cropping under irrigation, constitutes the 51,064,000 acres of arable land which appears in the summary of water and related land resources (table 1).



CANADA
WASHINGTON
OREGON
CALIF
NE
PACIFIC OCEAN
Bellingham
Skagit
Everett
SEATTLE
TACOMA
Olympia
Hoquiam
Aberdeen
Quinault R
Chehalis R
Cowlitz R
Longview-Kelso
Astoria
Grand Coulee
Okanogan R
Pend Oreille
Spokane R
SPOKANE
Coeur d'Alene
Wenatchee
Moses Lake
Yakima
Yakima R
COLUMBIA RIVER
SNAKE R
Lewiston
Walla Walla
Pendleton
Vancouver
PORTLAND
The Dalles
Tillamook
La Grande
Salem
WILLAMETTE R
John Day R
Baker
Newport
Deschutes
Weiser
Bend
Eugene
Umpqua R
Boise
Coos Bay
Burns
Malheur Lake
Roseburg
Owyhee
Rogue R
Grants Pass
Medford
Lake Abert
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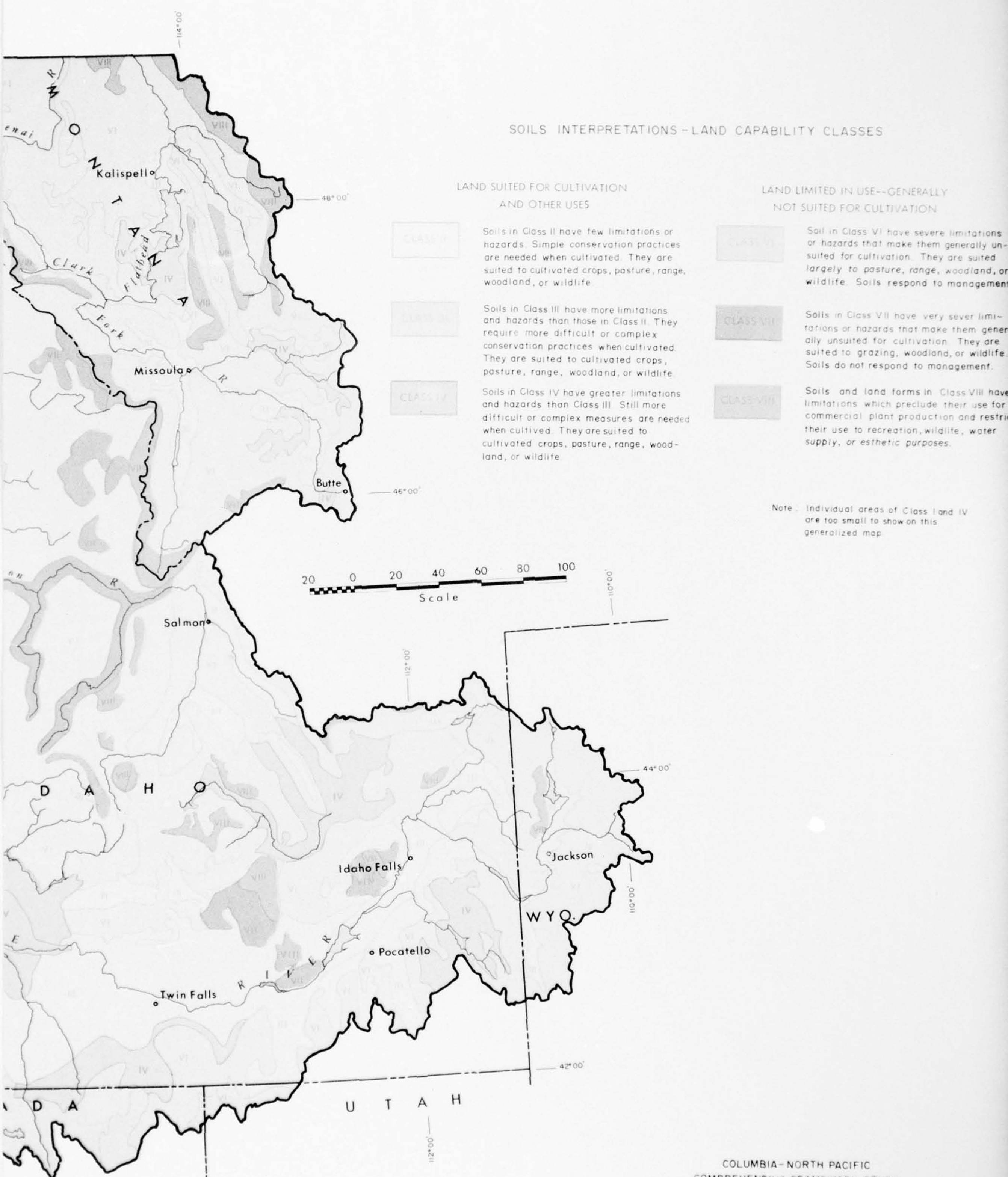
42°00'
124°00'
122°00'
120°00'
118°00'
N



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

LAND CAPABILITY CLASSES
THE REGION

FIGURE 6

Table 5–Summary of Land Capability Classes, 1966
Columbia-North Pacific Region

Land Capability Subclass[1/]	Subregions												
	1	2	3	4	5	6	7	8	9	10	11	12	Total
							(1,000 ac)						
I	1.0	69.1	51.8	-	43.6	3.0	20.0	11.6	171.5	1.8	-	-	373.4
IIe	132.8	324.5	110.5	386.4	233.3	385.8	211.1	56.9	279.9	229.6	-	26.0	2,376.8
IIw	95.6	42.8	41.9	3.0	81.5	1.2	-	116.6	305.4	256.3	305.0	8.5	1,257.8
IIs	88.0	132.7	102.9	39.3	151.5	37.1	128.7	43.5	320.9	94.6	10.0	-	1,149.2
IIc	98.7	-	-	140.5	12.0	-	216.0	-	-	22.0	-	60.0	549.2
Total II	415.1	500.0	255.3	569.2	478.3	424.1	555.8	217.0	906.2	602.5	315.0	94.5	5,333.0
IIIe	777.3	1,915.4	266.6	1,506.1	421.7	2,253.5	1,680.8	200.0	530.7	443.1	148.0	130.0	10,273.2
IIIw	67.8	72.7	41.9	31.1	91.3	111.1	12.0	104.6	256.3	232.8	315.0	300.0	1,636.6
IIIs	228.3	330.3	22.1	523.0	333.6	132.8	214.4	130.1	64.9	167.9	58.0	80.0	2,285.4
IIIc	62.2	199.6	-	173.2	10.4	-	67.0	-	-	-	-	-	512.4
Total III	1,135.6	2,518.0	330.6	2,233.4	857.0	2,497.4	1,974.2	434.7	851.9	843.8	521.0	510.0	14,707.6
IVe	2,070.7	1,175.2	320.1	399.4	338.0	687.6	2,724.5	233.2	575.2	1,317.6	866.0	175.0	10,882.5
IVw	136.9	35.0	29.7	50.2	9.0	76.3	45.0	189.8	245.7	469.6	72.0	85.0	1,444.2
IVs	732.2	292.9	75.4	250.3	78.5	65.5	268.0	43.7	51.3	331.9	293.0	155.0	2,637.7
IVc	63.2	-	-	424.3	64.1	104.0	-	-	-	-	-	130.0	785.6
Total IV	3,003.0	1,503.1	425.2	1,124.2	489.6	933.4	3,037.5	466.7	872.2	2,119.1	1,231.0	545.0	15,750.0
Vw	144.0	10.0	-	156.1	52.4	12.0	34.0	-	1.8	-	-	385.0	795.3
Vs	-	-	-	32.0	-	-	-	-	-	-	-	-	32.0
Vc	-	-	-	12.0	48.2	-	-	-	-	-	-	-	60.2
Total V	144.0	10.0	-	200.1	100.6	12.0	34.0	-	1.8	-	-	385.0	887.5
VIe	14,850.1	7,160.0	2,454.1	13,125.5	17,402.2	14,203.6	10,851.9	1,597.2	4,390.8	10,005.5	4,645.2	6,325.3	107,011.4
VIw	49.5	-	-	-	-	13.5	-	48.6	-	122.8	32.0	170.0	436.4
VIs	456.7	1,167.1	122.7	1,218.3	114.0	186.8	431.5	214.7	161.0	397.9	421.0	980.0	5,871.7
VIc	11.0	-	-	1,004.7	520.0	-	-	-	-	-	-	20.0	1,555.7
Total VI	15,367.3	8,327.1	2,576.8	15,348.5	18,036.2	14,403.9	11,283.4	1,860.5	4,551.8	10,526.2	5,098.2	7,495.3	114,875.2[2/]
VIIe	1,415.7	804.2	101.5	1,648.1	1,702.2	2,924.6	1,032.6	92.1	90.4	702.9	827.4	932.1	12,273.8
VIIw	0.6	-	-	-	-	-	-	-	-	24.8	12.0	20.0	57.4
VIIs	150.7	92.8	63.7	56.8	356.5	391.7	680.9	34.4	28.6	67.4	27.0	1,307.9	3,258.4
Total VII	1,567.0	897.0	165.2	1,704.9	2,058.7	3,316.3	1,713.5	126.5	119.0	795.1	866.4	2,260.0	15,589.6
VIII	1,186.4	256.5	46.5	1,501.5	1,333.5	781.1	203.8	75.6	128.4	165.7	415.0	105.0	6,199.0
Total Land	22,819.4	14,080.8	3,851.4	22,681.8	23,397.5	22,371.2	18,822.2	3,192.6	7,602.8	15,054.2	8,446.6	11,394.8	173,715.3

1/ Subclasses are: "e" water or wind erosion, "w" wetness of frequent inundation from overflow, "s" soil limitation, and "c" climatic limitation.

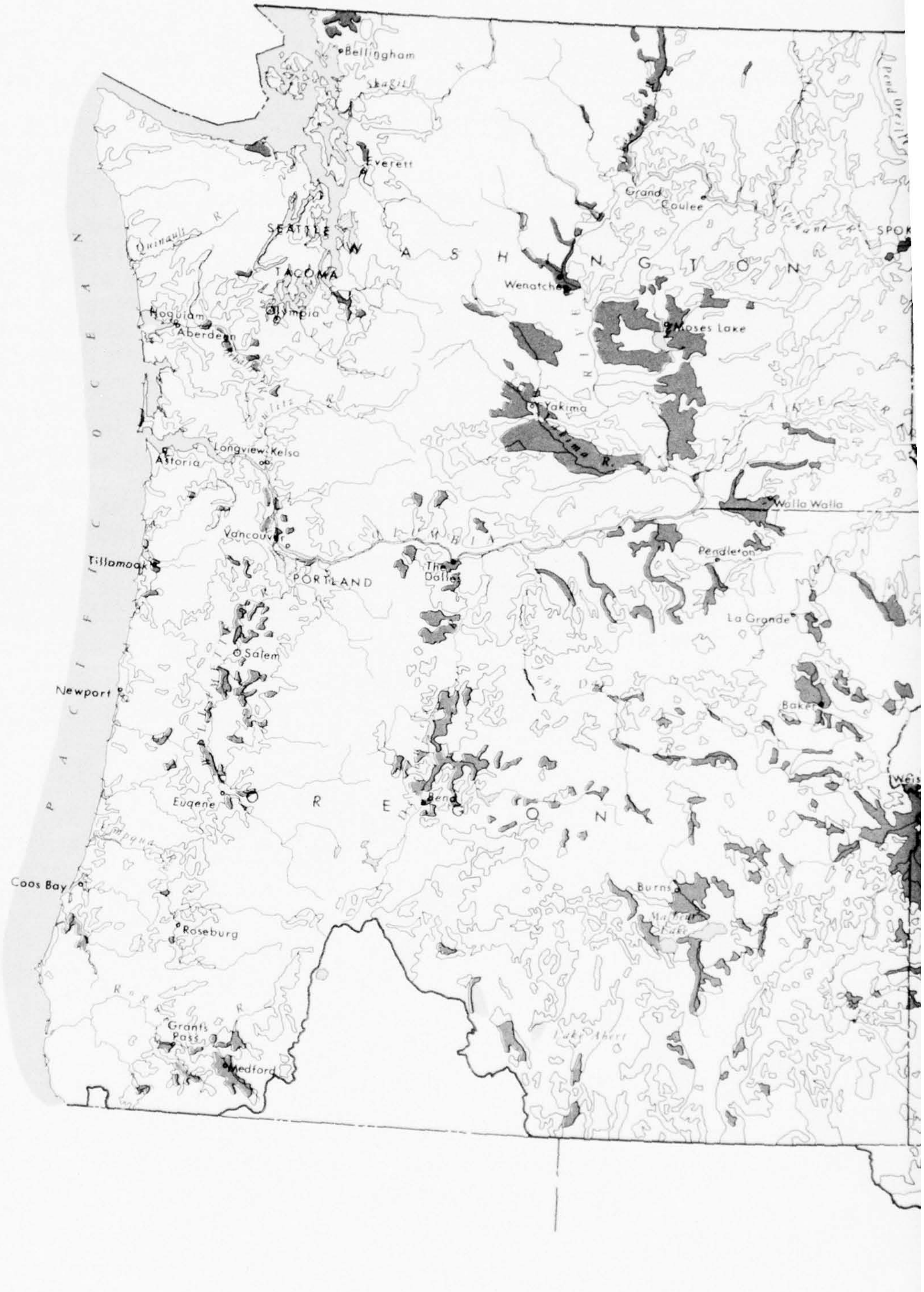
2/ An estimated 15 million acres are suitable for cultivation for crops when irrigated.

Source: Appendix IV, Land and Mineral Resources.

Potentially Irrigable Land

Approximately 31.7 million acres have been identified as potentially irrigable. Under irrigation, these lands would be suited for the production of climatically adapted agricultural crops, although in some cases they may have greater potential for nonagricultural uses. An additional 1.2 million acres, in an "other" potentially irrigable category, are primarily suited to producing limited forage for wildlife and livestock grazing but are not generally suitable for more intensive uses. A summary of potentially irrigable lands is shown in table 6. The general location of these lands is shown on figure 7.

Nearly half of these lands, more than 14 million acres, were placed in Irrigability Classes 1 and 2. Under irrigation, they would be suited to the production of a wide variety of climatically adapted crops and could be farmed and irrigated by modern equipment and methods. They are generally suited for gravity methods of irrigation. Class 3 is of only fair to marginal quality for irrigation development, being limited in both crop productivity and land use. Class 3 lands will generally be limited to sprinkler irrigation although grass or other close growing crops may be irrigated by wild flooding or contour furrows.



PACIFIC OCEAN
WASHINGTON
OREGON
Bellingham
Everett
SEATTLE
TACOMA
Olympia
Hoquiam
Aberdeen
Astoria
Longview
Kelso
Tillamook
PORTLAND
Salem
Newport
Eugene
Coos Bay
Roseburg
Grants Pass
Medford
Grand Coulee
Moses Lake
Yakima
Walla Walla
La Grande
Bend
Burns

COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

IRRIGATED AND POTENTIALLY IRRIGABLE AREAS

THE REGION

FIGURE 7

Table 6–Potentially Irrigable Land by Class[1/]
Columbia-North Pacific Region

Area and Subregion	Class 1		Class 2		Class 3		Other[2/]		Total	Percent of Grand Total
	(acres)	(percent)	(acres)	(percent)	(acres)	(percent)	(acres)	(percent)	(acres)	
Area A										
Subregion 1	110,900	(4)	645,800	(26)	1,753,700	(70)	-	-	2,510,400	8
2	451,000	(15)	1,116,800	(38)	1,403,500	(47)	-	-	2,971,500	9
3	60,100	(9)	262,400	(42)	309,400	(49)	-	-	631,900	2
Total	622,200	(10)	2,025,000	(33)	3,466,600	(57)	-	-	6,113,800	19
Area B										
Subregion 4	717,200	(16)	1,797,200	(40)	1,572,600	(35)	375,900	(9)	4,462,900	14
5	463,200	(9)	1,443,200	(29)	2,415,200	(48)	734,500	(14)	5,056,100	15
6	170,700	(5)	1,067,500	(32)	2,082,000	(61)	70,900	(2)	3,391,100	10
Total	1,351,100	(11)	4,307,900	(33)	6,069,800	(47)	1,181,300	(9)	12,910,100	39
Area C										
Subregion 7	692,400	(12)	2,360,400	(41)	2,672,400	(47)	-	-	5,725,200	17
9	318,400	(21)	528,500	(35)	655,900	(44)	-	-	1,502,800	5
10S	82,600	(10)	304,200	(38)	417,600	(52)	-	-	804,400	2
12	165,000	(6)	570,900	(19)	2,198,500	(75)	-	-	2,934,400	9
Total	1,258,400	(12)	3,764,000	(34)	5,944,400	(54)	-	-	10,966,800	33
Area D										
Subregion 8	68,400	(12)	138,800	(25)	351,500	(63)	-	-	558,700	2
10N	35,200	(4)	289,900	(36)	494,200	(60)	-	-	819,300	2
11	29,300	(2)	218,000	(14)	1,272,300	(84)	-	-	1,519,600	5
Total	132,900	(5)	646,700	(22)	2,118,000	(73)	-	-	2,897,600	9
Region	3,364,600	(10)	10,743,600	(33)	17,598,800	(53)	1,181,300	(4)	32,888,300	100
Rounded	(3,400,000)		(10,700,000)		(17,600,000)		(1,200,000)		(32,900,000)	
State										
Idaho	1,152,900	(13)	3,306,300	(39)	3,454,700	(40)	683,800	(8)	8,597,700	26
Montana	29,700	(2)	157,500	(13)	1,050,300	(85)	-	-	1,237,500	4
Nevada	17,900	(2)	150,400	(21)	505,100	(70)	49,500	(7)	722,900	2
Oregon	1,014,200	(9)	3,979,600	(34)	6,362,700	(53)	448,000	(4)	11,804,500	36
Utah	0	(0)	13,200	(52)	12,400	(48)	-	-	25,600	-
Washington	1,145,300	(11)	3,126,700	(30)	6,160,300	(59)	-	-	10,432,300	32
Wyoming	4,600	(7)	9,900	(15)	53,300	(78)	-	-	67,800	-

1/ Does not include 7,344,000 acres of land presently irrigated in 1966.

2/ Bureau of Land Management-designated lands generally not meeting the potentially irrigable land classification specifications used for this study.

Source: Appendix IX, Irrigation.

MINERALS

The region's mining industry is characterized by large, well established operations which have been in production for many years and have sufficient reserves for many more. The mines are principally producers of metals such as gold, silver, copper, lead, zinc, antimony, and mercury. Equally important are the industrial mineral operations found throughout the region, such as those producing sand and gravel, crushed rock, limestone, pumice, expandable shale, brick and tile clay, and refractory clay.

Although the region is not of great mineral wealth when compared to the Nation, mineral resources are important in its economy and provide vital raw materials for both regional and national industries. Approximately $10 billion in wealth have been extracted from the region's mines and quarries.

Metals

The two outstanding metal producing areas are the Coeur d'Alene area in Idaho and the Butte district in Montana. Principal resources are copper, silver, gold, lead, and zinc. A third major area is in northeastern Washington in Pend Oreille and Stevens counties. In addition, many other smaller productive or potentially productive areas are scattered throughout the region.

Production from major copper deposits in the Butte area are expected to continue at the current rate for many years. The once productive Heddleston district, north of Butte, has been revived and is expected to be a major copper producer. Over 50,000 tons of copper are indicated in the Miners Ridge (Glacier Peak) area, Washington; however, no production has come from this deposit.

In the Coeur d'Alene area, where 90 to 98 percent of the known silver, lead, and zinc reserves are located, estimates indicate a minimum of 10 years' production at current rates. Exploration is active, and there are likely potential reserves for many years.

Large potential resources of low grade lead and zinc ores exist in northeastern Washington. Known resources equal 40 years at current annual production rates, and estimated resources over 100 years.

In the 10 years prior to 1951, the Northwest produced about 11.5 percent of the Nation's new gold. Because of the discontinuance of placer mining, production in Oregon has dropped markedly. In 1958, Washington ranked sixth in U.S. gold production. The Knob Hill Mine in the Republic district was the fourth largest gold producing mine in the Nation. Western Montana, northeastern Oregon, and southwestern Oregon have major potential for new gold. Other deposits are scattered throughout the region, but are not economic to mine under present market conditions.

Large reserves of manganese ores are found in western Montana. These have been developed in recent times, and manganese production has in some years accounted for a large share of national output.

Uranium ore is available in two deposits north of Spokane, and recent additional discoveries make resumption of mining and milling in the area likely. Smaller deposits have been located in other areas.

The Nation's only nickel currently being mined comes from Nickel Mountain near Riddle, Oregon. Estimated reserves are sufficient for 10 to 15 years at present production rates. Oregon also contains the major cinnabar deposits, which are located in the central and eastern part of the state.

Idaho has deposits of tungsten, antimony, mercury, cobalt-columbian-tantalum, and rare earth metals. Potential reserves of these metals are adequate for several years of production.

Nonmetals

Nonmetal reserves, both in tonnage and value, are primarily construction industry items such as sand and gravel, stone, and clay. As low unit value items, they must be produced near the market.

Sand and gravel deposits are widespread and the supply virtually inexhaustible, but deposits near urban markets or convenient to construction are becoming more critical.

Limestone is widespread but varies greatly in purity. It has many uses, and the resource is very large and adequate for the foreseeable future.

Clay, also widespread, is used largely according to its physical and mineralogical character. Common clays are most prevalent and are used mostly near urban centers for common brick and tile. Sources of high grade refractory or high alumina clays of greater value are more limited. Overall, enormous clay reserves are available.

Phosphate rock production is of major importance, as it is used in making fertilizers, elemental phosphorus, and some minor products. Reserves are estimated at several billions of tons.

The principal source of vermiculite for the United States is in this region. Resources are extensive and the outlook for increased future production is favorable. Fluorspar deposits near Darby, Montana, have several years reserves available. Barite, garnet, and magnesite are other nonmetals available and resources are generally adequate for the foreseeable future. Since World War II, Washington has been the largest producer of magnesite. Reserves are still available. The olivine reserve in Washington is one of the largest known in the Nation.

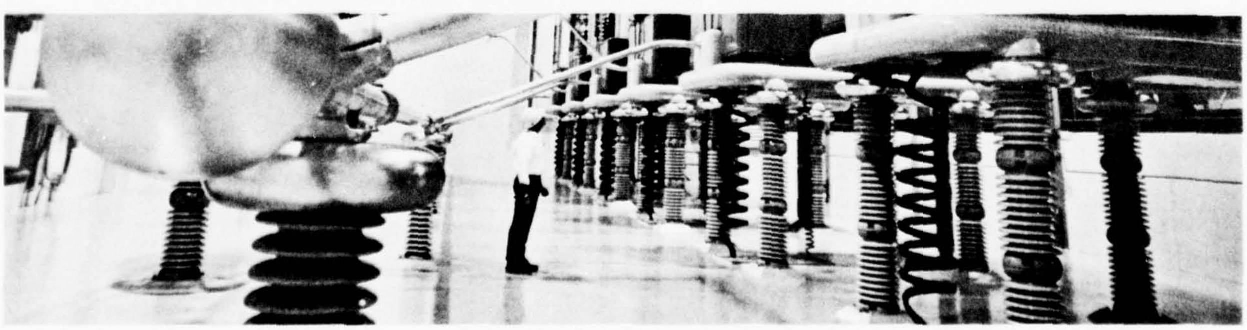
Mineral Fuels

The region's coal reserves, most of which are in western Washington, are estimated to total 6.2 billion tons. Interest in coal has been revived recently with construction of a coal-fired thermal-electric plant near Centralia to supplement the present hydroelectric generation. Southern Oregon also contains some formerly productive coal fields in the Coos Bay area, but there has been very little activity in recent years.

No producing oil or gas fields exist, although considerable exploratory drilling has found small quantities of both.





The development and use of water and related land resources helps maintain an employment base in the Columbia-North Pacific Region. There is an extensive system of Federal, State, local government, and private water resource development projects. Many new programs and projects are being initiated to keep pace with expanding needs. Hydroelectric power and the abundance of water provide an impetus to industrialization. Over 7 million acres of cropland are under irrigation. Food processing and manufacturing have gone hand in hand with these developments. Navigation, harbors, and waterways have been expanded and extended. Population has increased with the growth of employment and business opportunities. With this growth, the demand for outdoor recreation, including sport fishing and hunting, has accelerated rapidly.

Over the years a series of compacts and treaties have evolved which must be considered in planning for the management and use of water. During the period 1853 to 1864, the United States entered into 14 treaties with Indian Tribes of the region. Under terms of these treaties, reservations were established. The United States Supreme Court has held that, in treaties creating Indian Reservations, the right to use water from streams and rivers on, bordering, or traversing Indian Reservations was reserved by the United States along with the reservation of the land itself. *Winters v. United States*, 207 U. S. 564 (1908). Further, the quantity of water so reserved was not limited to the amount of water used at the time the Indian Reservations were established. *Conrad Ins. Co. v. United States*, 161 F. 829, 835 (9th Cir. 1908). The United States Supreme Court has also held that, with respect to the water rights reserved by the United States for use on Indian Reservations, such waters are exempt from appropriation under State law. *Winters v. United States, supra.*

International treaties, such as the 1910 Boundary Waters Treaty with Canada and the 1961 Columbia River Treaty with Canada, are of particular importance to the Columbia River System. In the latter treaty, the United States has agreed to operate the existing hydroelectric plants and any new projects on the main stem of the Columbia River, beginning in 1964, so as to make the best use of Canadian storage and thereby produce the maximum amount of power benefits possible for sharing by the two countries. Canada's entitlement is one-half of the downstream power benefits produced in the United States by Canadian storage. The three Canadian storage projects will reserve up to 8.45 million acre-feet of flood control space on May 1 of each year with an additional 12 million acre-feet available as "on call" storage.

The operation of the Columbia River System has become complex, requiring the continuous coordination of many agencies. Coordination is accomplished

by the Columbia River Management Group, an interagency body operating within the general limits of the Pacific Northwest Coordination Agreement developed September 1964 by 16 electrical power systems under the Flood Control Plan which includes Columbia River Treaty storage.

With the diverse ownership of dams on the Columbia River and the constraint imposed by treaties and compacts, a plan of coordinated operation has been carried out over 20 years. This operation considers all uses and has been successful in providing adequate control measures. The success is possible because the runoff patterns are well known months in advance, which permits water and reservoir operation to be scheduled for various uses long before critical periods occur. In general, results of this effort have been to reduce winter and spring floodflows on the main stem and to augment flows during the low water season.

The Willamette Basin also contains a highly complex management system for water resources. The comprehensive plan, initially authorized by the Flood Control Act of 1938 and repeatedly modified by subsequent acts, provides for a system of multipurpose reservoirs operated to serve several varied interests. Although the major use of the system is for flood control, it also serves navigation, power, and irrigation. Incidental benefits also accrue to water quality, recreation, and fish.

WATER DEVELOPMENT AND CONTROL

Storage

Almost every major stream is controlled to some degree by storage dams serving a variety of purposes. In total there are 194 reservoirs with storage capacities of 5,000 acre-feet or more. These reservoirs have a total active storage capacity of more than 40 million acre-feet, making them a valuable asset in the use and management of water resources. An extensive and growing recreational use has resulted from reservoirs constructed primarily for other purposes. Reservoir releases during the low-water season have restored or preserved resident and anadromous fish in some streams.

Small reservoirs of less than 5,000 acre-feet number 26,090 and store nearly 400,000 acre-feet. These reservoirs are also used for a variety of purposes. Most of the smaller ones are farm ponds used for stock watering, recreation, irrigation, etc. Their major contribution to water management is through the retention of runoff during high precipitation periods for use during dry seasons. Although overall effects on total runoff patterns are small, on some watersheds they are important. The major contribution of these small reservoirs is in the Snake River Basin and Mid Columbia Subregion, where they are extensively used for stock watering on rangeland.

Levees and Channelization

Levees and channel improvements were the earliest flood control structures and remain among the more important structural measures. Stream channelization, modification, and improvements are employed almost everywhere to some extent. Existing local protection projects comprise 1,794 miles of levees, 3,463 miles of channel improvement and stabilization, and 3,022 miles of bank protection.

The projects range from improvements on small creeks where material has been taken from the channel and placed on the banks to massive levees 25 to 30 feet high designed to withstand major floods on the Columbia River. The degree of protection is equally variable. Some minor levees are overtopped almost every year; while others effectively protect urban areas against floods as infrequent as once in a hundred years.

Instream Use

The waters are used over and over again for production of hydroelectric power, for recreation, for navigation, for sport and commercial fish and wildlife, and for water quality control. The flowing waters in the stream represent a major part of the natural environment.

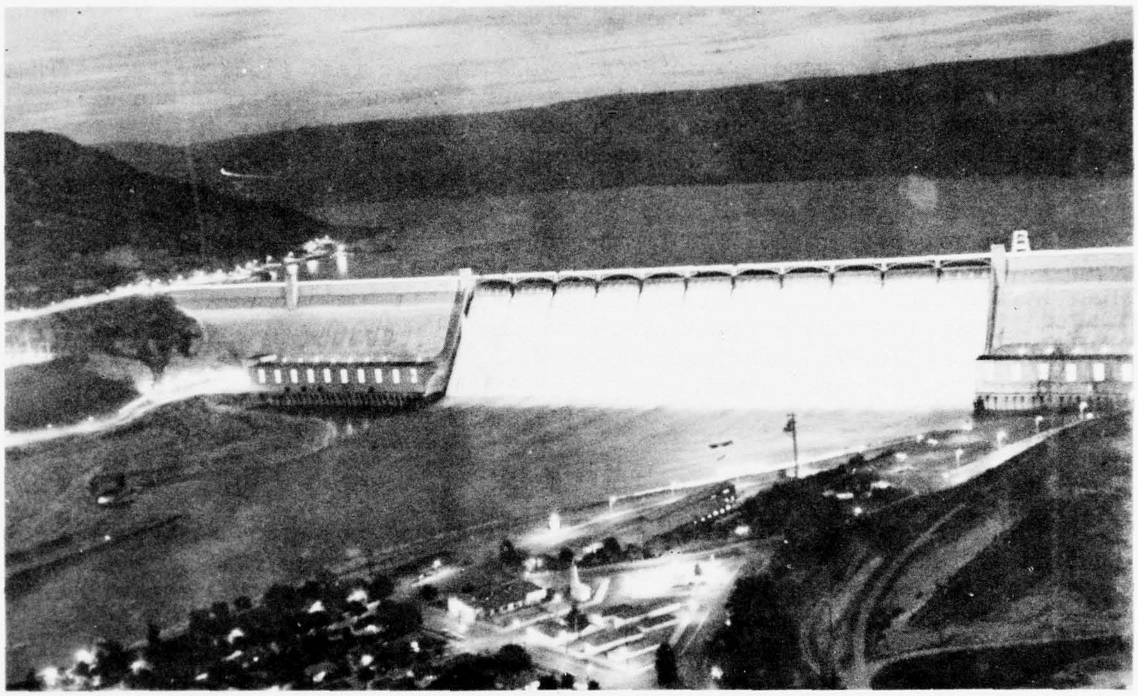
Hydropower

Hydroelectric power ranks as a dominant instream water use. It is absent only in Washington's sector of Subregion 10 and in Oregon's Closed Basin, Subregion 12. The region's runoff is used an average of three times for power production.

The total of the region's electric generating capacity as of December 10, 1969, was 18,963 megawatts installed at 186 plants. Well over 90 percent of this capacity was hydroelectric. In addition, there were 9,167 megawatts of capability under construction, about 85 percent of which was hydroelectric. A large share of the hydro capacity currently under construction consists of expansion of existing projects.

About half of the existing (December 1969) capacity is installed at Federal multipurpose hydro projects. All but a few minor plants are a part of the Federal Columbia River Power System, whose production is marketed by the Bonneville Power Administration. In addition to the 8,517 megawatts of existing capacity, there are 7,263 megawatts of Federal hydro capacity under construction.

The non-Federal utilities have 120 hydroelectric projects with a total installed hydroelectric capacity of about 9,188 megawatts. Added capacity of 501.6 megawatts is being installed at the Rocky Reach project of Chelan County PUD in Washington.



Grand Coulee Dam on the Columbia River in Washington, constructed and operated by the Bureau of Reclamation, has a generating capacity of over 2 million kilowatts (USCE).

The bulk of the generating capacity is located on the Columbia River where the plants are both federally and nonfederally owned. The total storage on the Columbia River and its tributaries usable for power generation is nearly 45 million acre-feet, of which about 31 million acre-feet are in existing projects and nearly 14 million are under construction. This storage is operated in direct coordination for the Columbia River Power System. Additional power benefits result from storage in minor projects and in reservoirs constructed for nonpower purposes.

Recreation

Water-related recreation use of rivers, reservoirs, and lakes includes water contact activities (boating, fishing, swimming, and water skiing) and related noncontact activities (picnicking, camping, and sightseeing). This use amounted to about 77 million recreation days in 1965 or 41 percent of the total recreation days engaged in that year. The economic significance of this use is immense.

Most parts of the region contain streams and water bodies which provide opportunities for numerous recreation uses in a highly attractive natural environment. Numerous mountain lakes add much to scenic and esthetic values and provide many recreation opportunities. On some lakes, which serve as municipal water supply reservoirs, water contact activities are restricted.

Some rivers in the region have been identified as having national or state significance in their natural condition and have been designated to remain in this status.

Competition for recreation resources has led to some conflicts between groups of recreationists: for example, between those who sail and those who water ski, or between those who use motorized recreation vehicles and those who seek peace and solitude. Such conflicts are becoming severe, especially on smaller water bodies, as the number of recreationists using fixed resources continues to increase.

Fish & Wildlife

The region's streams, lakes, and estuaries are the habitat of a variety of anadromous and resident fish, waterfowl, and shellfish. In most parts of the region, these natural resources constitute an important recreation asset; in the lower Columbia, Puget Sound, and a number of coastal estuaries, the commercial fishery is an important economic activity. Sport fishing in 1965 exceeded 21 million user-days, and commercial fish landings totaled over 183 million pounds.

Anadromous fish inhabit nearly all accessible rivers and streams tributary to the Pacific Ocean, Puget Sound, and the Columbia River. The most important species are the salmon and steelhead trout which account for more than 90 percent of the anadromous sport fishing and 95 percent of the commercial harvest. Anadromous fish represent about 20 percent of all sport fishing and nearly 25 percent of the commercial fishery.

Few resident species sustain commercial harvest. Trout and char are more highly regarded by most sport fishermen than other resident fish. Rainbow trout, the most widely distributed and numerous, are found in lakes and streams in every subregion. Resident fish accounted for more than 68 percent of all sport fishing in the region in 1965.

Salmon and searun trout provided about 4,960,000 man-days angling in 1965. Most salmon angling takes place in the lower Columbia River and its tributaries, the Snake River, coastal streams, and waters of the Pacific Ocean.

One of the many high quality streams found in the Columbia-North Pacific Region (Idaho Fish and Game Dept.).

Sport fisherman use of most species of marine fishes and shellfishes, except razor clams, is low. Practically all bays and estuaries support bay clam and Dungeness crab sport fisheries. Recreational use of all shellfish was estimated to be 1,073,000 man-days in 1965. Ocean perch, rockfish, lingcod, flounders, greenling, and other marine fishes are caught both from shore and from sport fishing boats.

Recreational use of marine fishes amounted to an estimated 706,000 angler-days in 1965. In coastal and ocean waters, about 112 million pounds of marine fish were harvested commercially (some 60 percent of the total commercial fishery), and an estimated 27 million pounds of shellfish were caught.

Sport angling for American shad, striped bass, and white sturgeon is important in local areas. All of these species, with the exception of the white sturgeon, are produced primarily in the tributaries near the Pacific Ocean and in the lower Columbia River. A significant sport fishery for white sturgeon occurs in about a 30-mile reach of the Snake River below Hells Canyon Dam.

The region is host to many species of waterfowl, some of which are year-round residents. The mallard is probably the most important in terms of hunter interest, followed by the Canada goose. Although the region produces large numbers of ducks and fairly important numbers of geese and swans, it is primarily important for supplying habitat used during migration periods.

The region contains 21 national wildlife refuges and many State-owned or managed areas primarily dedicated to waterfowl. The coastal bays, estuaries, and lakes supply important habitat, particularly for diving ducks and black brant. The shallow lakes and marshes of the Oregon Closed Basin are a nationally famous waterfowl habitat; other lakes, streams, and marshes, especially in western Oregon, central Washington, and southern Idaho, are also important.

An estimated 1,436,000 man-days were spent hunting waterfowl in 1965 of which 276,000 occurred in the Upper Columbia Subregion. Puget Sound was second with 208,000 man-days, followed by the Upper and Central Snake with 176,000 and 156,000 man-days, respectively.

Navigation

Navigable waterways are a valuable natural endowment of the region that have been used ever since man occupied the area. Navigation has become more important with regional growth and today occupies a significant place in the economy.

Navigation use includes deep and shallow draft ocean commerce, commercial fishing, inland commercial navigation, and recreational boating. The latter is an important use of water regionwide. Foreign and coastwise waterborne commerce totals over 45 million short tons annually. Commodity groups included in both categories were agricultural products, forest products, nonmetallic minerals, petroleum products, and miscellaneous. Primary metals, ores, and crude petroleum were included in the foreign and coastwise commerce only.

Internal movements of commerce total over 52 million tons annually of which 25.2 million are within Subregion 11, and 8.2 million are along the coast. The remaining 18.9 million tons annually are on the Columbia-Willamette-Snake River waterway with about 90 percent being on the Columbia River below The Dalles and on the Willamette below Salem. In the eastern part of the region, commercial navigation is limited to movement of rafted logs to mills on a few isolated large bodies of water.

Deep draft commerce by ocean vessels occurs at 16 salt and fresh water ports. Navigation is important on the Columbia River between Astoria and the Portland-Vancouver area. Numerous navigation aides such as channels, groins,

The barge "Kenai" in McNary Lock on the Columbia River (USCE).

levee construction, bank stabilization, and jetties have been provided in this stretch.

Locks in the Columbia and Snake River dams from Bonneville upstream extend river navigation up the Columbia to the Tri-City Area on Lake Wallula and 145 miles up the Snake River. Above McNary Reservoir on the Columbia River, navigation now is generally limited to log rafting on Franklin D. Roosevelt Lake and movement of general cargo to isolated communities on Lake Chelan. Open river navigation is possible, usually for recreation purposes, on many other river reaches such as on the Snake River to Hells Canyon Dam, the Middle Fork Salmon River, the mainstem Salmon River, and many parts of the Clearwater River.

Although the Willamette River is used for navigation from its mouth to Corvallis, a deep draft channel is maintained only to Portland. Major restrictions to Willamette navigation are the obsolete Willamette Falls locks at Oregon City and shallow channel up river.

There are four deep draft harbors developed along the coast of Oregon and Washington and 12 in the Puget Sound and lower Columbia River areas. Many smaller estuaries serve recreational, fishery, and other commercial functions. Most projects have received improvement such as jetties and breakwaters at the entrances and some channel dredging.

The Strait of Juan de Fuca, Puget Sound and adjacent waters have many bays and inlets with deep waters which serve as harbors. In the Seattle area, a deep water channel with navigation locks connects Puget Sound with Lake Union and Lake Washington. The lower estuaries of the Snohomish and Duwamish Rivers are developed for navigation. In the lower Skagit River, navigation is limited to occasional log rafts.

Water Quality

Although water quality is not a direct instream use such as fish, navigation, or recreation, the quality has a direct physical and economic impact on how the water is utilized.

In contrast to many other parts of the Nation, water quality in the Columbia-North Pacific Region is still generally very good. At the same time, however, serious pollution problems in several places result in poor quality water, damage to sport and commercial fisheries, and undesirable public health and esthetic conditions. Extensive cleanup of pollution sources in the Willamette River and Lake Washington has resulted in rapid improvement of water quality.

The most widespread and important problem from the public health aspect is that of bacterial contamination. Nearly every stream below major population centers fails to meet generally accepted coliform bacteria criteria for water-contact recreation and water supply sources.

Particularly important are the areas of low dissolved oxygen, since salmonid fish require dissolved oxygen levels of at least 5.0 mg/l for migration and higher levels for rearing and spawning. Most dissolved oxygen problems result from the discharge of inadequately treated municipal and industrial wastes. Impoundments also have a significant effect on the dissolved oxygen level.

High water temperatures (above 68°F., 20°C.) in the Lower Columbia and Lower Snake Rivers and several coastal streams have deleterious effects on anadromous fish.

Nitrogen supersaturation, resulting from spills over dams, is a serious problem throughout the Lower Snake and Columbia Rivers. High temperatures seem to magnify its effect. A special study is underway to determine the reason for its persistence in the river, its lethal limits, and possible solutions.

Aquatic growths which can cause taste and odor problems, clog irrigation canals, fish nets and lines, reduce esthetic appearance, and depress dissolved oxygen levels, occur in a number of areas. The Snake River and lower Columbia River are examples of this problem.

Algae growths are sometimes a problem in a few reservoirs. American Falls, Brownlee, Long Lake, and Fern Ridge reservoirs are examples of water bodies where this has occurred.

A few stream reaches, notably in the Clark Fork and South Fork Coeur d'Alene Rivers, have been rendered biologically sterile by the discharge of heavy metals from mining operations.

The volume of streamflow is also an important factor affecting water quality. Occurrence of low flows critical to quality control results from natural low water conditions and in some instances to the management regimen of upstream storage. The Spokane River, Yakima River, Snake River below Milner Dam, and lower Malheur River, as well as many small streams, are examples of streams that experience critical low flows. Low flows are sometimes the result of withholding water in storage or the actual diversion of a significant part of a stream. Reservoirs in the region do not have storage specifically allocated to water quality control. However, streamflow provided for other purposes is often of considerable assistance in improving water quality.

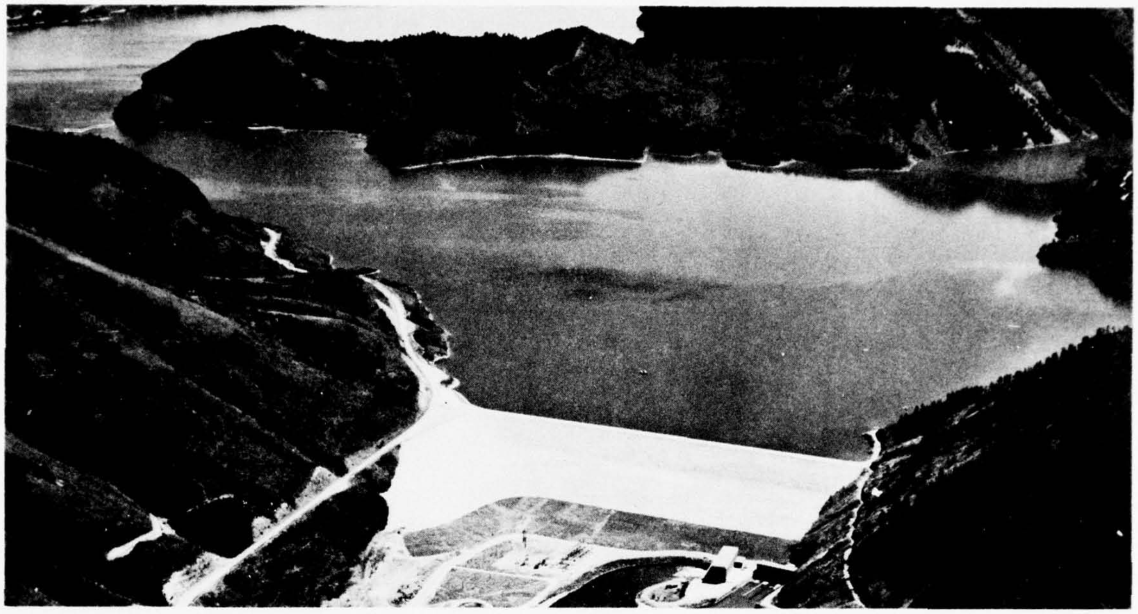
Diversions

Surface Water

Surface water diversions equal approximately 10 percent of the total regional discharge. These diversions serve a variety of purposes of which irrigation accounts for about 95 percent. Irrigation, together with municipal, industrial, and rural-domestic uses, requires over 36 million acre-feet annually. Diversions are also made for hydroelectric power, waste dilution, and to a limited extent for fish hatcheries, recreation, and waterfowl and game habitat.

Irrigation In 1970, 33.7 million acre-feet of surface and ground water were diverted to irrigate the 7.5 million irrigated acres. Return flows amounted to 17.9 million acre-feet, resulting in a net depletion of 15.8 million acre-feet. About 90 percent of the diversions came from surface sources (including storage) and the remaining 10 percent from ground water. Some 2.0 million acres are subject to shortages which average about 2.2 million acre-feet. Estimated water use for 1970 is shown on table 24 in the Irrigation Section.

Municipal and Industrial Water The annual withdrawal of water for municipal use is estimated to be 1.1 million acre-feet annually, for industrial use 2.1 million acre-feet, and for rural-domestic and livestock over



Palisades Reservoir, completed in 1958, stores 1.4 million acre-feet of water for irrigation, flood control, power, and recreation (USBR).

0.2 million acre-feet. The major water demand for these uses is in the area west of the Cascades.

Some 829 municipal water supply facilities furnish water to over 4.5 million people. Heavily populated Subregion 11 (Puget Sound) has a municipal use of 303 mgd, or 33 percent of the region's total; the Clark Fork-Kootenai-Spokane and Willamette subregions account for 14 and 20 percent respectively. Excepting the Oregon Closed Basin, with its minor needs, the remaining subregions use from 29 to 54 mgd for municipal purposes.

Total industrial water use, exclusive of thermal power cooling water, is about 1,920 mgd. The pulp and paper industry is the largest water user with 934 mgd, or nearly 60 percent of the total industrial requirements. The primary metals, food processing, lumber and wood products, and chemical products industries are also major users. Over 70 percent of this total water use is concentrated in 34 major service areas.

In general, industries have developed adequate independent water supplies, although a number of food processing firms obtain water from municipal facilities. In the western subregions, water supplies are most often from surface sources. The largest water using industries in the eastern subregions generally depend on surface sources, but most smaller ones use ground water.

Rural-domestic water use, which includes stock watering and small scale irrigation, approximates 210.5 million gallons per day. About two-thirds are used for the rural population and the remainder for livestock watering.

Table 7—Summary of Ground-Water Withdrawal by Use and Subregion, 1970
Columbia-North Pacific Region

Type of Use	1	2	3	4	5	6	7	8	9	10N	10S	11	12	Region
							(1,000 ac-ft)							
Municipal	117	36	27	61	49	25	30	22	69	2	16	51	2	507
Industrial	137	33	25	96	35	2	12	115	108	6	20	31	2	622
Rural Domestic	28	21	20	34	30	11	10	10	21	4	13	11	4	217
Irrigation	137	410	80	2,096	211	35	191	9	239	10	2	97	44	3,561
Fish & Wildlife	1	1	-	3	-	-	1	3	-	-	-	-	8	17
Total	420	501	152	2,290	325	73	244	159	437	22	51	190	60	4,924

Source: Appendixes IX, Irrigation; XI, Municipal & Industrial Water Supply; and XIV, Fish and Wildlife.

Ground Water

The estimated withdrawal and use of ground water in 1970 is summarized in table 7. Total annual ground-water withdrawal is estimated to be about 5.0 million acre-feet as of 1970, of which about 3.6 million acre-feet are for irrigation and 1.3 million acre-feet for municipal, industrial, and rural-domestic water supply. Depletions total about 2,300 cfs, most of which result from irrigation.

Over a million acres are irrigated from ground water of which three-fourths are in Idaho, mostly in the Snake River Basin above Thousand Springs. Ground water is also used to irrigate more than 100,000 acres in the Willamette Valley of Oregon.

Ground-water withdrawals for public supply are fairly well distributed but are greatest in the Spokane Valley and the Puget Sound area (Subregions 1 and 11).

LAND USE AND MANAGEMENT

Through its various agencies, the Federal Government manages more than 95.5 million acres or 55 percent of the total regional land area, the Forest Service and the Bureau of Land Management being the principal managing agencies. Private individuals and corporations own almost 40 percent, the balance being held by state, county, and local governments. Table 8 lists the ownership in detail by present cover and land use.

Indian tribal and allotted lands total nearly 4.8 million acres, both inside and outside Indian Reservations. These areas are owned by the individual Indians or tribes with trust responsibilities vested in the Bureau of Indian Affairs.

Table 8—Cover and Land Use, 1966
Columbia-North Pacific Region

Ownership & Location	Cropland	Forest Land	Rangeland (1,000 ac)	Other Land	Total
Ownership					
Department of Agriculture					
Forest Service	-	45,727.3	6,677.6	2,001.3	54,406.2
Other Agriculture	.4	-	46.8	.5	47.7
Total	.4	45,727.3	6,724.4	2,001.8	54,453.9
Department of the Interior					
Bureau of Land Management	-	4,486.6	24,275.9	754.9	29,517.4
Bureau of Indian Affairs[1/]	364.1	2,658.3	1,635.7	133.9	4,792.0
National Park Service	-	2,503.9	255.7	634.5	3,394.1
Fish & Wildlife Service	28.5	64.2	373.1	142.7	608.5
Bureau of Reclamation	14.0	17.0	1,033.5	71.6	1,136.1
Other Interior	-	-	-	10.0	10.0
Total	406.6	9,730.0	27,573.9	1,747.6	39,458.1
Department of Defense	-	83.4	459.6	204.0	747.0
Other Federal	-	2.3	946.3	11.1	959.7
Total Federal	407.0	55,543.0	35,704.2	3,964.5	95,618.7
State	247.4	4,341.3	3,111.8	751.8	8,452.3
County	-	227.0	-	260.4	487.4
Municipal	-	222.6	3.6	251.9	478.1
Total Public Non-Federal	247.4	4,790.9	3,115.4	1,264.1	9,417.8
Total Public	654.4	60,333.9	38,819.6	5,228.6	105,036.5
Total Private	20,149.4	25,509.6	19,925.0	3,094.8	68,678.8
Total Land Area	20,803.8	85,843.5	58,744.6	8,323.4	173,715.3
States					
Idaho	5,988.5	20,901.0	21,998.5	1,897.1	50,785.1
Montana	843.4	12,708.0	1,370.4	999.8	15,921.6
Nevada	155.1	106.0	3,012.4	23.0	3,296.5
Oregon	5,347.9	27,479.6	22,521.9	2,211.2	57,560.6
Utah	8.2	25.9	203.6	3.2	240.9
Washington	8,304.6	22,970.0	8,522.2	2,878.8	42,675.6
Wyoming	156.1	1,653.0	1,115.6	310.3	3,235.0
Total	20,803.8	85,843.5	58,744.6	8,323.4	173,715.3
Area A					
Subregion 1	1,552.1	18,242.1	1,698.1	1,327.1	22,819.4
2	3,308.8	5,652.1	4,583.9	536.0	14,080.8
3	686.3	1,508.9	1,534.8	121.4	3,851.4
Total	5,547.2	25,403.1	7,816.8	1,984.5	40,751.6
Area B					
Subregion 4	3,781.3	4,296.9	13,555.8	1,047.8	22,681.8
5	1,628.9	4,190.5	16,838.7	739.4	23,397.5
6	3,077.8	13,537.1	5,041.8	714.5	22,371.2
Total	8,488.0	22,024.5	35,436.3	2,501.7	68,450.5
Area C					
Subregion 7	3,570.6	8,328.3	6,358.1	565.2	18,822.2
9	1,456.1	5,272.0	58.8	815.9	7,602.8
10S	423.0	10,155.0	114.0	293.0	10,985.0
12	365.0	1,893.0	8,733.1	403.7	11,394.8
Total	5,814.7	25,648.3	15,264.0	2,077.8	48,804.8
Area D					
Subregion 8	201.1	2,665.0	67.9	258.6	3,192.6
10N	161.8	3,673.6	54.6	179.2	4,069.2
11	591.0	6,429.0	105.0	1,321.6	8,446.6
Total	953.9	12,767.6	227.5	1,759.4	15,708.4
Region	20,803.8	85,843.5	58,744.6	8,323.4	173,715.3

1/ Private lands held in trust by the Federal Government.
Source: Appendix IV, Land and Mineral Resources.

The states own nearly 8.5 million acres. Of the seven states, only Nevada does not own land in the region. Management is spread among many state agencies. In most states, the Natural Resource or Forestry Departments, Park, Fish and Game, and Highway Departments have principal responsibilities.

Cropland

Nearly 21 million acres, or 12 percent of the land area in the region, are used as cropland. Of this total, over 13 million acres are under dryland management and over 7 million acres are presently being irrigated. Small grain crops occupy from a third to a half of the cropland, except along the western coastal edge where over two-thirds of the cropland is in forage crops. Orchards occupy nearly 10 percent of the cropland in the Willamette Valley in Oregon and in the central Washington valleys. They are generally irrigated in the latter area. Another large irrigated area in central Washington, the Columbia Basin Project, contains row crops, hay, and seed crops. In the remainder of the Columbia Plateau, much of the cropland is fallow with grain the principal crop. Production of nearly half of the row crops, including vegetables, potatoes, sugar beets, and corn is concentrated in the Snake River Plains in Idaho. Nearly half of the region's irrigated land is located in southern Idaho.

Forest Land

The region contains 85.8 million acres of forest land (11 percent of the Nation's total) of which 70.4 million acres are commercial forest land. Of the 15.4 million acres of noncommercial forest land, 5.1 million acres are of commercial character but are in areas reserved as national parks, wilderness and primitive areas, and state, county, and municipal parks. The remaining 10.3 million acres of noncommercial forest lands are unsuitable for raising commercial timber crops.

The region's 70.4 million acres of commercial forest land represent 14 percent of the Nation's commercial forest area. However, this also represents 42 percent of the Nation's potentially most productive forest land. The Columbia-North Pacific Region contains an estimated net volume of 217 billion cubic feet of timber on commercial forest land, nearly one-third of the Nation's total timber volume.

Although timber production is one of the key uses, the forests are equally important as they provide sources of water, recreation, hunting, fishing, sight-seeing, and other outdoor activities.

Rangeland

Rangeland comprises 58.7 million acres, or slightly less than 34 percent

of the total regional area. These lands provide 7.3 million animal unit months (AUM's) of livestock grazing annually. Public land contributes a little more than 4.3 million AUM's and private rangeland accounts for 3.0 million AUM's.

Forage is used primarily for grazing livestock (cattle, sheep, and horses), but it is also used by many species of wildlife.

The combination of overgrazing and range fires in early periods caused many range areas to be in poor condition. In recent years, the application of improved management practices, including fire control, has resulted in an upward trend in most areas. Continued effort is being made by both the private and public land managers to improve range conditions, but considerable work remains to be done.

Other Land

The high alpine areas of bare rock peaks, such as the Rocky Mountains, and areas of lava flow mostly related to the Columbia River Basalt are highly important from the standpoints of water production and esthetic values. Another increment of the other land category is the small water areas of less than 40 acres and streams less than one-eighth mile wide. Barren areas (over 5 million acres or almost 3 percent) plus small water areas (almost 0.5 million acres or almost 0.3 percent of the land area) together equal almost 6 million acres, or 3 percent of the region, and are significant mainly for water supply or esthetics.

The balance of the other land category is occupied by roads, farmsteads, urban and industrial areas, and similar uses. Table 8 shows the amounts of the major uses within the category of "other land."

Wildlife Habitat

The varied climate and topography provide habitat suitable for many native and some introduced big game, upland game, waterfowl, fur animals, and other wildlife species.

All of the states in the Columbia-North Pacific Region have agencies charged with the management of the wildlife resources. As these agencies do not control non-Federal land, cooperative agreements are made with private landowners for management benefiting wildlife. On public lands, various legal and administrative rules apply; but, in general, the wildlife agencies guide land developments that will result in the least damage to wildlife. Public and private lands are usually not managed exclusively for wildlife. These uses must be fitted into the major management objective of the landowner or administrator. Scattered throughout the region are lands administered by State and Federal wildlife agencies and managed exclusively for the benefit of wildlife.

These lands comprise 36 national refuges totaling some 642,000 acres and 100 State wildlife management areas with a total of 778,000 acres.

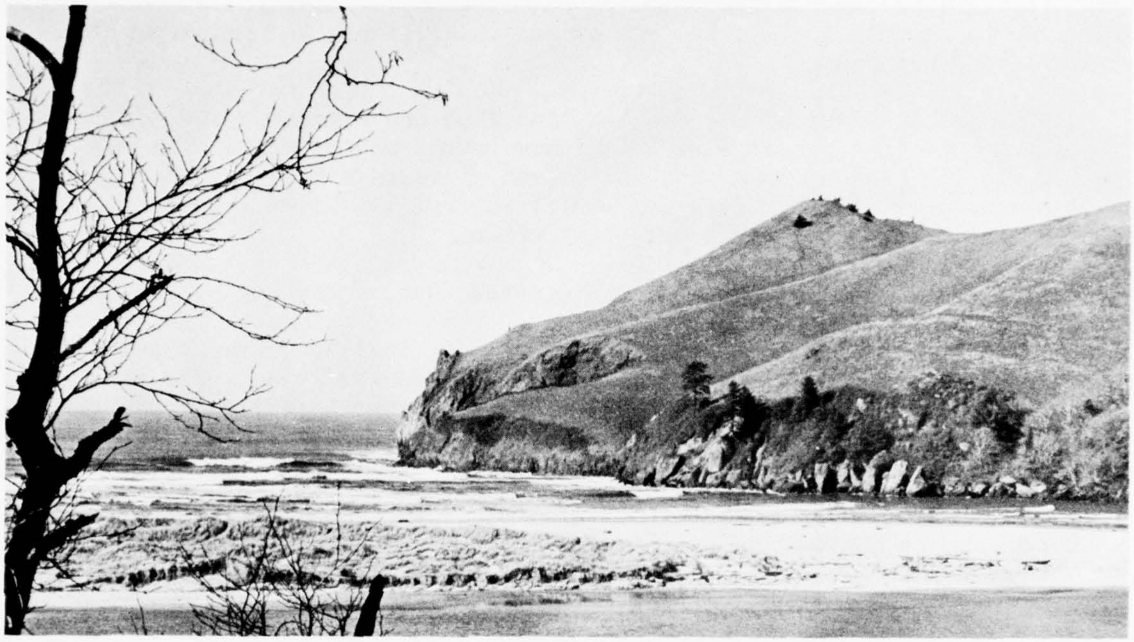
Wildlife is also an important factor in the region's economic outlook and provides millions of recreation days. Big game hunting accounted for an estimated 4.8 million man-days and about $50 million in expenditures by hunters. Approximately 3.7 million hunter-days and $17 million were expended on upland game, and an estimated 1.4 million man-days and about $10 million were spent hunting waterfowl.

Coastal Zone & Estuaries

The coast of Washington and Oregon, fronting on the Pacific Ocean, is nationally famous for its natural scenic qualities. Extraordinarily impressive is the wide diversity of the scenic geologic, biological, and recreational resources of the shoreline. Ecological and geological settings provide inspirational rewards and features to stir the imagination. Included are smooth sandy beaches, rugged and massive bluffs, pounding and surging surf, natural sea caves, numerous salt water coves and inlets, estuaries, offshore rocks and reefs, and sand dunes.

The coastline is an area of constant change, here receding by erosion, there advancing by deposition, and in some places undergoing submergence or rising from the water. These alterations in the physiography of the seashore reflect the complexity of the coastal zone's terrestrial foundations and the natural forces which act upon the zone. This complexity is also evident in the variety of plants and animals found in the coastal and estuarine areas. Some have adapted to the shallow waters close to the shore, to the windswept lands near the ocean, or to water that is neither fresh nor salt. In many cases, they have adapted themselves to the combination of living in and out of the water. The plants, the animals, and many other things--the land, the ocean, the wind, the clouds, the rain, the streams that flow into the ocean here and there along the coastline--compose the coastal zone.

Perhaps the most important contribution of the estuaries lies in the biological sphere. The estuarine habitat is essential to the life process of many species of fish life. Some of these species spend the whole or a part of their lives in the estuarine environment, while others are dependent on estuaries for vital links in the food chain. Anadromous fish, such as salmon and steelhead, use estuaries as a transition zone in their migrations between fresh and salt water. Other commercially and recreationally important fish species require estuarine nurture for survival to maturity. Shad and striped bass spawn in estuaries. Herring, the major food for salmonids, also need the estuaries for successful spawning. A variety of other fish use this habitat for spawning, rearing, and feeding.



Salmon River Bay on the Oregon coast (Oregon State Game Commission).

The production of clams, oysters, and crabs for recreational and commercial uses is also important. Hardshell clams are found on open beaches and in the more saline portions of the estuaries, while softshell clams are most frequently found in sandy mud bottoms in the upper tide flats. Dungeness crabs are an important crop for both recreational and commercial harvest. Estuaries are the nursery ground for juvenile crabs which support the offshore commercial fishing as well as the sport and commercial harvest within the estuaries.

The value of marine fish and shellfish off the Oregon-Washington coast is indicated by the 1965 commercial harvest when an estimated 111.6 million pounds of marine fish and 27.1 million pounds of shellfish valued at $8.5 million and $6.4 million respectively were sold in the market place. Recreational marine fishing was an estimated 706,000 angler-days with a value of some $3.4 million, while about $5.3 million were spent for nearly 1.1 million man-days of shellfishing.

Estuarine mud flats and waters and marsh vegetation provide important wintering, feeding, and resting areas for the many ducks, geese, and swans using the Pacific Flyway. The black brant, a sea goose, is seen where eel grass is common, while limited numbers of whistling swans winter in bays such as Nehalem, Nestucca, and Siletz. Estuaries also provide habitat to large numbers of shore birds, such as plovers and sandpipers. Mammals that use Oregon

estuaries include fur bearers such as beaver, mink, muskrat, otter, and nutria, while marine mammals include the harbor seal, sea lions, and occasionally porpoises and whales.

The social value of the beaches, the fish and wildlife, the seascapes, open space, and the natural environment are beyond measurement. The Federal Government, the states, counties, and private interests have provided access and numerous recreational areas for public enjoyment. These range from view-points, wayside stops to large overnight parks.

The estuary has a complicated ecosystem, but, fortunately, one that is quite resilient except where grossly abused. Man and his activities exert pressure on the estuaries and the coastal zone by filling of the tidal areas, polluting the land and waters, dredging harbors, constructing roads and buildings, logging, plowing uplands, and changing the character of the rivers. Yet man is relatively unaware of the full impact of all these activities on the coastal zone and its resources. Fortunately, however, this resource yet can be retained by implementation of planned control measures.

Coastal Zone of Oregon

The coastal zone of Oregon is the tidal shoreline excluding the drainages of the Umpqua River upstream from Scottsburg and the Rogue River upstream from Agness. Included in the subregion is the entire coastline of Oregon from the California-Oregon border north to the Columbia River estuary. Of the approximately 350 miles of coastline, about 250 miles have usable beaches, and the remaining 100 miles consist of headlands and rocky shores. About 43 percent of ocean front in Oregon has sand dune formations. Approximately 66 miles of the Oregon shoreline are federally owned, while 129 miles are owned by non-Federal public bodies, and 157 miles are privately owned.

Oregon has 14 major estuaries, including the Columbia River estuary and Young's Bay, in addition to the minor estuaries of south coastal streams such as the Rogue, Elk, Sixes, Pistol, Chetco, and Winchuck. Though small, the minor estuaries are necessary for the survival of anadromous fish, principally the chinook salmon, which use the rivers. During the summer the juvenile chinook feed and grow in river mouths and move seaward with the fall freshets. The Rogue River for instance is famous nationally for its sport fishery value. The estuarine area totals only slightly more than 56,000 acres but is invaluable to the region and the state because of the contribution it makes to biological, economic, and social functions.

The Oregon Legislature enacted Chapter 608, Oregon Laws 1971, creating a Coastal Conservation and Development Commission to prepare a comprehensive plan for the coastal zone which shall reflect a balancing of the conservation and development of the zone's natural resources. In addition, legislative action extended control of alteration activities in the State's waterways to


WASHINGTON
OREGON
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LINCOLN
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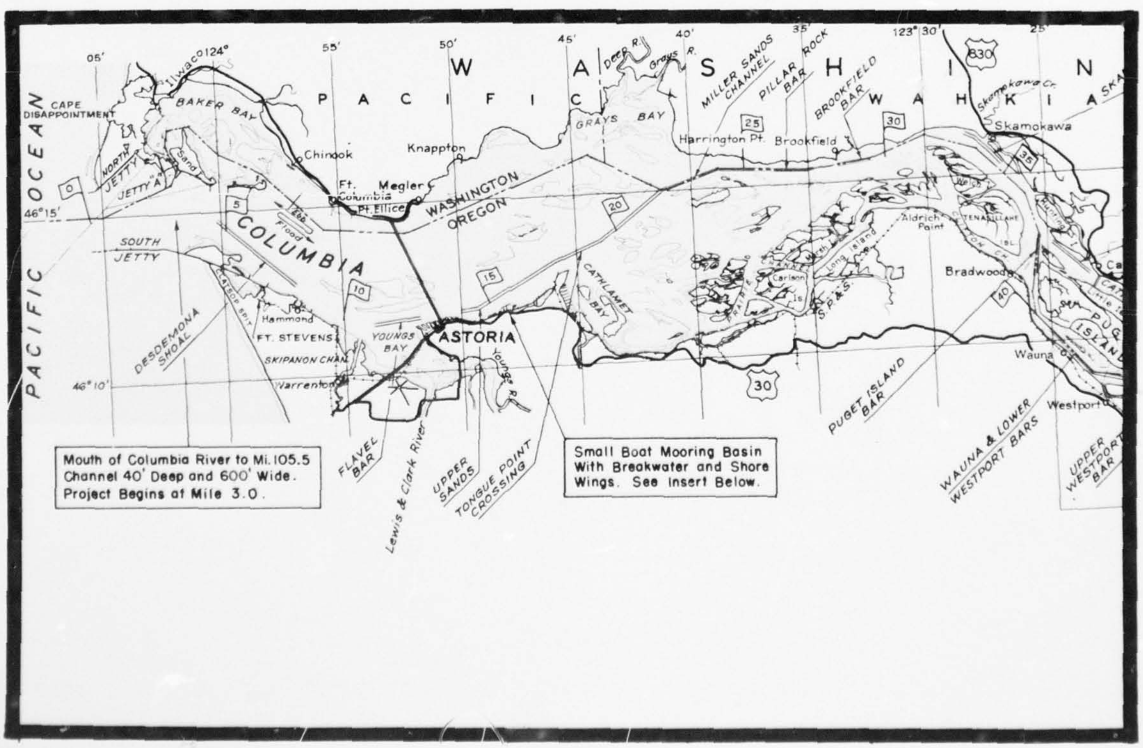
OCEAN
OREGON
CALIFORNIA

include filling of beds of State waters in a manner similar to previously existing regulation of removal of materials. Also, Chapter 324, Oregon Laws, 1969, requires the Governor to establish zoning regulations for land in any county in which there has not been substantial progress as of December 31, 1971, toward zoning all land in the county.

Columbia River Estuary

For the purposes of this study, the Columbia River estuary (in Oregon and Washington) is considered to extend about 20 miles upstream from its mouth, the limit of salt water intrusion; however, the tidal influence extends to Bonneville Dam. At the upper end the estuary is about 3 miles wide, while the opening between the jetties at the mouth is 2 miles. Between these points, the estuary widens to a maximum of 10 miles. The shoreline consists generally of forested banks and bluffs with small deltas at the mouths of tributary streams. Shoreline development is limited to light residential and recreational development, including ports devoted to fishing activities. A deep draft channel is maintained in the river as far as Vancouver and Portland. There are several deep draft ports on the Columbia River; only the port of Astoria lies within the estuary.



The Columbia River estuary provides migration routes and habitat for fish species of major importance to both the commercial and sports fisheries. All anadromous species using the stream system of the Columbia River pass through the estuary in their migrations to and from the ocean. In addition to providing passage, the estuary serves migratory fish as a zone of transition between fresh water and salt water. Salmon, the principal anadromous fish, supports commercial and sport fisheries both in estuarine and offshore waters. Sturgeon are taken by both commercial and sport fishing in the river, while ground fish, crabs, and shrimp are captured offshore.

Coastal Area of Washington

Washington's tidal shoreline totals 2,337 miles, of which 1,928 miles face the inland waters of Puget Sound and the Straits of Georgia and of Juan de Fuca, and includes the shoreline of 172 significant islands of the San Juan Archipelago. Of the remaining shoreline, 218 miles are accounted for by the two major estuaries, Willapa Bay and Grays Harbor, 34 miles by the north shore of the Columbia River estuary, while the ocean shoreline makes up the balance of 157 miles. Wide sandy beaches characterize 389 miles or about 13 percent of the total shoreline. Two-thirds of this mileage occur in short reaches in Puget Sound and the Strait of Juan de Fuca, while the relatively long beaches on the ocean shoreline north of the Columbia River make up almost all of the balance.

The water surface area of Willapa Bay ranges from 60 to 110 square miles, depending on tidal stage. Wide beaches make up a relatively small part of the bay shoreline. The bay is rich in fish and wildlife resources and has commercial oyster production. Clams, crabs, and marine fish ranging from anchovies to sturgeon all utilize the bay and have both sport and commercial values. Willapa Bay is also an essential resting place, feeding area, and wintering ground for important segments of the migratory bird population. About 210 species of birds are resident or regular visitors to Willapa and adjacent uplands, and at least 66 have been recorded as nesting in the area.

Grays Harbor, the estuary of the Chehalis, Humptulips, and several other rivers, is smaller than Willapa Bay and is located about 17 miles north of it. Fish and wildlife resources are significant. Significant numbers of anadromous fish pass through the estuary, and its tidelands provide habitat for waterfowl. Intensive industrial shoreline development has occurred at the cities of Aberdeen and Hoquiam, located at the head of the estuary.

From Quinault River to Cape Flattery, the shoreline is characterized by narrow, rocky beaches with steeply sloping banks. Adjacent lands are heavily forested. East of Angeles Point, the shoreline along the Strait of Juan de Fuca has two water areas protected by sand spits. Port Angeles, a deep draft harbor, is protected by Ediz Hook while Dungeness Spit gives protection to Dungeness Bay, a shallow estuary important for its shellfish production and heavy use by waterfowl and other water-oriented wildlife. The coastline from Dungeness Bay to Port Townsend has two deep indentations, Sequim Bay and Port Discovery. Beaches along this reach are generally narrow.

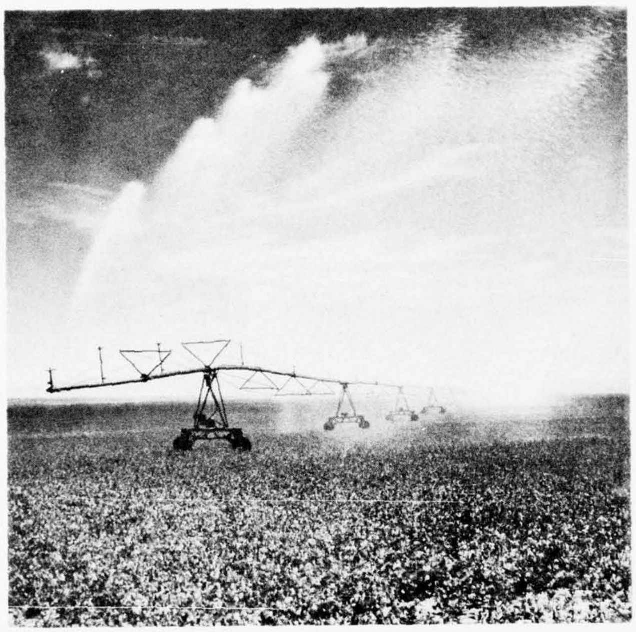
Puget Sound and adjacent waters consist of the marine and estuarine waters south and east of Port Townsend and the extension of territorial waters north of Port Townsend to the United States/Canadian boundary, including the waters of the San Juan Archipelago. Puget Sound is one of the deepest salt water basin areas in the United States. Depths of 600 to 800 feet prevail in the northern section, while south of the Tacoma Narrows, near the headwaters, 300 feet is typical. Shore ownership is largely private. Only 262 miles, or less than 9 percent, are in public ownership both Federal and non-Federal, while 2,764 miles are privately owned.

The Legislature of the State of Washington enacted Chapter 286, Laws of 1971, entitled the "Shoreline Management Act of 1971." This act provides for the planning and management of shorelines of the State, along both fresh and salt water through cooperation of the Washington State Department of Ecology and local government entities.

This act constitutes an alternative to Initiative 43, sponsored by the Washington State Environmental Council which vests all planning and control with the State. The Secretary of State was directed to place this 1971 Act on the ballot in conjunction with Initiative 43 at the next ensuing regular

election in 1972 to allow the people to select the one which will govern future action.

The 1971 Act took effect on June 1, 1971, and continues in force and effect until the Secretary of State certifies the election results on this 1971 Act. If affirmatively approved at the ensuing regular general election, the act shall continue in effect thereafter.



POPULATION, EMPLOYMENT, AND INCOMF

The baseline economic projections of population, income, employment, and demand for agricultural and forestry goods and services were made for the United States and for each water resource region. The economic projections for the Columbia-North Pacific Region derive their base elements from this program. Within this framework, production projections for the principal resource industries, agriculture, forest industries, and mining and primary metals, were developed.

Projections of the major components of economic growth are shown in table 9. For the purposes of this study, the projections for the Puget Sound and Adjacent Waters, and the Willamette Basin Type 2 studies were substituted for OBERS projections for Subregions 9 and 11. These type 2 projections each utilize different assumptions and methodologies than OBERS.

Approximately 69 percent of the region's 1970 population of 6.4 million was concentrated west of the Cascade Range. Population growth has followed the national distribution patterns with increasing urban, decreasing rural farm, and relatively stable rural nonfarm concentrations.

Table 9—Population, Employment and Income, 1960, with Projections for 1980, 2000 and 2020
Columbia-North Pacific Region

Item	1960[1]	1980	2000	2020	1960-1980	1980-2000	2000-2020	1980-2020
		(thousands)			Average Annual Trends (percent)			
Projections by OBERS[2]								
Population	5,426	7,294	9,710	12,680	1.5	1.4	1.3	1.4
Employment	1,979	2,869	3,866	5,067	1.9	1.5	1.4	1.4
Personal Income (1958 dollars)	12,981,737	29,881,702	68,563,235	154,437,238	4.7	4.2	4.1	4.2
Total Earnings (1958 dollars)	9,558,311	23,263,268	51,681,849	114,560,277	4.3	4.1	4.1	4.1
Projections by OBERS as modified with Type 2 Projections[3]								
Population	5,426	7,611	10,690	15,395	1.7	1.7	1.8	1.8
Employment	1,979	2,835	3,999	5,700	1.8	1.7	1.8	1.8

1/ Data for income, 1962, and earnings, 1959.
2/ Projections developed March 1969 by the Office of Business Economics, Department of Commerce and the Economic Research Service, Department of Agriculture (OBERS).
3/ OBERS projections adjusted by the substitution of the Willamette and Puget Sound Type 2 projections for Subregions 9 and 11, respectively.
Source: Appendix VI, Economic Base and Projections.

Future growth in population will depend on economic development and is projected to increase from 6.4 million in 1970 to 15.4 million in the year 2020. The Willamette and Puget Sound subregions are projected to have annual rates of growth significantly greater than those of the region. Approximatel 75 percent of the regional population is projected to be located west of the Cascade Range by 2020.

Total employment is estimated to increase from about 2.0 million in 19 to 5.7 million in 2020. Employment, like population, will likely be concentrated in the western portion of the region. Annual growth in employment dur the next 50-year period is projected to be 1.8 percent.

Total personal income for the region which amounted to $12.98 billion 1962, is projected to increase at slightly higher than the national rate. Pe capita income in the region has exceeded the national level in each of the census years 1940, 1950, and 1960, and in 1962 was $2,325.

THE ECONOMY

The basic characteristics of the economy of the Columbia-North Pacific Region are similar to those of the Nation. In 1960, noncommodity industries accounted for 68 percent of the total employment of about 2 million. At the national level, approximately 65 percent of the total employment in 1960 was associated with noncommodity.

About 1,290,000 employees were engaged in noncommodity industries in 19 Employment in these industries is projected to triple by 2020. These service industries are relatively low consumers of water.

Forest related industries are highly important to the economy of the region. In 1960, they employed about 180,000 employees. Over the next 50 yea forest industry payrolls are projected to more than double. The number of man facturing employees is projected to decline; but the forest management employm is projected to increase.

In 1964, the value of agricultural commodity production exceeded $1.5 billion, with about 60 percent from crops and 40 percent from livestock and poultry. Associated employment exceeded 150,000 persons. The total value of agricultural production is projected to more than double by 2020, while the number of employees decreases to 90,000. The largest relative increases in crop production (more than three times by 2020) are projected for sugar beets, potatoes, vegetables, and fruits (table 10).

Manufacturing of petroleum, chemicals and allied products, primary metals, textiles and other items, which employed about 278,000 people in 1960 is expected to triple by 2020. A large percentage of these employees are located in the Puget-Willamette Trough areas. By 2020 employment in the

Table 10—Production of Agricultural Commodities, 1964, with Projections for 1980, 2000 and 2020
Columbia-North Pacific Region

Commodity	Unit	Production 1964[1]	1980[2]	2000[2]	2020[2]
		(thousands)			
Small grains[3]	tons	6,096	9,700	10,700	11,800
All hay	tons	7,747	11,800	15,300	20,900
Dry beans	cwt.	6,834	8,500	10,100	12,300
Sugar beets	tons	4,588	9,000	14,000	20,300
Potatoes	cwt.	55,419	128,000	168,000	220,000
Vegetables	cwt.	20,464	33,900	44,200	57,000
Fruits, nuts & berries	tons	1,258	2,100	2,800	3,700
Forage, seed, hops & mint	lbs.	407,222	504,000	656,000	852,000

1/ Estimated from Census of Agriculture and Statistical Reporting Service data.
2/ Appendix IX, Irrigation.
3/ Small grains include wheat, oats, barley, rye and corn.

food and kindred products industry is projected to increase only two or three thousand above the 1960 level of 58,900, but output is projected to triple.

In 1965, mineral production in the region was valued at approximately $373 million. Metals such as copper, lead, zinc, and silver comprised 43 percent of this value, and about 33 percent was from gravel, sand and stone production.

LAND USE

Although population growth and increased economic activity will place greater demands on the region for all types of use, the land base is essentially fixed. The existing and projected cover and land use is shown in table 11.

As indicated, cropland is projected to increase over 0.8 million acres by 2020, forest land and rangeland will decrease by about 1.7 and 2.3 million acres respectively, and "other land" will increase by more than 2.1 million acres. The balance of the change is projected to occur in water areas with an increase of nearly a million acres. Additional details regarding these changes are found under Problems and Projected Needs.

Table 11—Cover and Land Use, 1966 with Projections for 1980, 2000, and 2020
Columbia-North Pacific Region

Type	Year			
	1966	1980	2000	2020
	(1,000 ac)			
Cropland	20,804	21,552	21,407	21,642
Forest Land	85,844	85,416	84,795	84,160
Rangeland	58,745	57,309	57,089	56,461
Other Land	8,323	8,954	9,708	10,488
Total Land	173,716	173,231	172,999	172,751
Water Areas	1,909	2,394	2,626	2,874
Total Area	175,625	175,625	175,625	175,625

Source: Appendix IV, Land & Mineral Resources; Appendix VI, Economic Base & Projections.

As a basis for formulating the framework plans, each water and related land resource was inventoried, and needs were determined using 1968 eonomic projections developed by the Office of Business Econcmics, the Economic Research Service, as modified by the Willamette and Puget Sound Type 2 studies. The basic projections were translated into water and related land needs. This process resulted in several categories of needs for each subregion and time period. Needs for a general use or function are expressed quantitatively wherever possible, but social needs are mostly in qualitative terms. Water requirements are expressed as consumptive or nonconsumptive for key locations and specified target dates. Comparison of these requirements with available resources and their current capacity and use indicated the additional management and development needed.

NEEDS FOR GOODS AND SERVICES

The needs for goods and services of a region result from the desires of the people. Goods and services are needed to satisfy the basic human requirements for food, clothing, and shelter, and for secondary wants such as recreation, esthetics, and security.

Certain needs require the furnishing of goods and services to meet a consumptive need of the people; these include food and fiber, consumer goods, and electric power. Other needs involve the furnishing of a service to eliminate or reduce problems that cause economic or other losses. These latter needs include relief from flood damages, damages caused by shoreline and watershed erosion, wildfire damage, and degradation of water quality.

The principal economic variables related to the needs for goods and services are population, employment, income, and gross regional product. The first three variables are summarized in table 9 which shows the 1960 base and projected values for target years 1980, 2000, and 2020.

Needs for goods and services for the base year, 1970, were estimated upon existing data and reasoned judgment. Based on the economic variables shown in table 9, needs for goods and services were projected using OBERS Series C-1968 projections, and the Willamette and Puget Sound and Adjacent Waters Type 2 Study projections for Subregions 9 and 11.

Electric Power

Basically, electrical power needs are projected to future years by extrapolation of historical data modified by population projections and judgment as deemed appropriate.

Navigation

Future needs for waterborne commerce are determined from a summation of extrapolated projections of cargo categories by subregion. Projected needs for small boat facilities are based on commercial fishing and recreation demands.

Water Quality

Water quality needs are generally proportional to population and economic activities. These needs include updating water quality standards consistent with beneficial uses to be protected to insure that the aquatic environment is protected from ecological disruption and impaired usefulness resulting from unwise or improper disposal of waste water.

Municipal & Industrial Water Supply

Municipal and industrial water supply needs are also proportional to the projected population and industrial needs; some on a per capita basis and others on a unit production basis. Increased efficiencies were also incorporated in the projected needs.

Flood Control

Flood control needs are expressed as dollars of average annual flood damages. Future flood damages were estimated by stream or river basin for the various assigned categories (forest, agriculture, residential, industrial, etc.) based upon appropriate growth factors.

Flood damages are projected to increase substantially in the future due to increases in population, economic activity, standard of living, and use of flood plain areas. Needs have been separated by major streams and their larger tributaries. The minor streams are included in the related land programs.

Food and Fiber

Future needs for food and fiber are based upon projected national population, per capita consumption, exports, manufacturing use, and changes in consumption patterns resulting from higher per capita income. The National production needs were then allocated among the several regions.

Projected needs for food crops to be satisfied by the Columbia-North Pacific Region are essentially the same as those developed by OBERS.

Production figures for only a few specific crops were revised to reflect actual production and yields. Translation of needs into land requirements included factors such as increased yields, more efficient application of fertilizers and waters, and land capability.

Fish and Wildlife

Future needs for hunting and fishing opportunities are based on population. Fishing needs include species for commercial use expressed in pounds of catch. Sport fishing and all varieties of hunting are expressed in man-days. The quality of future fishing and hunting was assumed to remain at least as high as now enjoyed.

Recreational Opportunities

Projections of needs for general recreational opportunities are based upon population, participation rate by activity, and translation of activity days to recreation days. The recreation needs expressed in this report are limited to water-based recreation.

Related Land Programs

The related land program needs are based on projections of land use (crop, range, forest, and other) and foreseeable land treatment measures required to support the increased production, and generally improve the overall management of the land resource. Needs include erosion and sediment control, water conservation, and protection and management of forest and rangeland.

PROBLEMS AND PROJECTED NEEDS

The following sections cover problems and needs in more detail. The subject matter includes a discussion of preservation of the natural environment; the coastal zone and estuaries which have problems and needs unique to that particular portion of the region; and the nine functions of water and related land shown in table 12, Needs Summary, located at the end of this section.

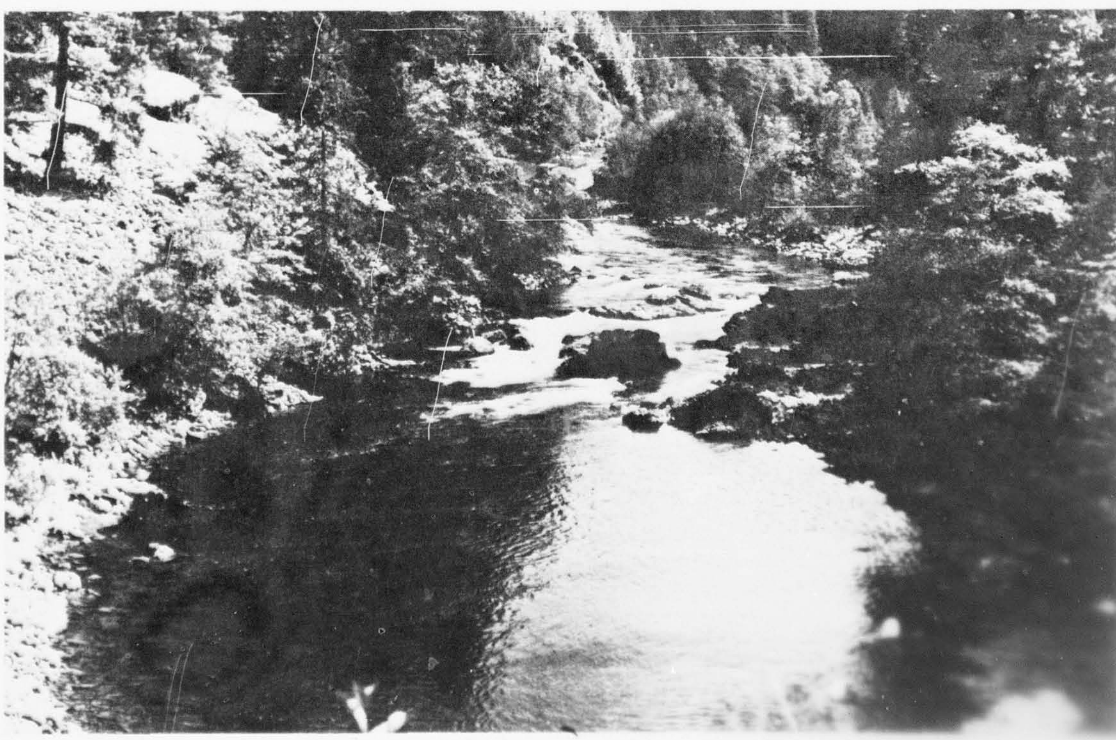
Preservation and Enhancement of the Natural Environment

Although the Columbia-North Pacific Region has large areas of relatively virgin mountains, plains, and valleys, the face of the land is constantly changing by urban and industrial growth, expansion of trans-

portation systems, and recreational development, as well as through natural processes. With population projected to more than double by 2020, there is a need to define and implement ways of life that are compatible with the preservation of the region's natural and manmade amenities, and yet provide an acceptable opportunity for earning a livelihood in an environment which will enhance human life.

To assure an adequate supply of land and water for future use, measures must be initiated to protect and, in some cases, enhance their quality. A full range of outdoor recreation opportunities now exists within the region. Multiple-use is necessary to insure that these opportunities remain available for future generations.

There is a need to maintain many streams in their free-flowing state and some estuaries in natural condition because of their biologic, scenic, esthetic, and natural recreational values. During the low-water season, streamflows must be maintained at adequate levels for recreational, environmental, and fishery purposes. Low flow augmentation is required on certain streams to enhance fish habitat as well as to improve water quality during summer months. In some cases, upstream storage reservoirs would provide a means for satisfying the need for augmented flows and reducing the adverse effects of floodflows during spawning periods.



"There is a need to maintain many streams in their free-flowing state..."

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The primitive and wilderness areas that have been set aside should continue to be preserved in their natural state. In addition, other areas deserve protection for their values as a source of mental stimulation, inspiration, satisfaction, and appreciation.

Wetlands should be retained to preserve habitat for waterfowl and other water-oriented birds and mammals. There is a need to preserve areas of historical and unique civic value. Numerous sites are located throughout the region that should be investigated for this purpose. Thorough identification of the archeological resources would add greatly to the store of scientific knowledge about pre-existing cultures in the Pacific Northwest. Some known sites have already become of doubtful value because of the activities of amateur artifact collectors.

There is a substantial need for management programs of the seacoast estuaries and related shorelands. The large expanses of open, green space along the Columbia River are an existing resource of great environmental value. Preservation of these areas in a substantially unaltered form would provide rural landscape near a large, growing metropolitan area.

Finally there is a need for governmental planning and public education directed toward retaining environmental quality.

Coastal Zone and Estuaries

As coastal waters are the ultimate recipient of the residual, nonreclaimable fraction of the wastes from man's activities, and their ability to absorb such wastes without degradation is finite, waste management systems must be made more effective, and new concepts and practices developed. The environment of the narrow coastal margin of the continent must be maintained in a healthy and esthetically attractive condition if it is to continue to satisfy multipurpose requirements.

The coastal zone has developed so rapidly that local governments are experiencing difficulty in planning for orderly growth, and inresolving conflicts. The task has been complicated by the lack of knowledge and procedures necessary for formulating sound decisions, and by confusion or division of responsibilities among the various levels of government.

Almost all of the estuaries have been subject to some losses of productive lands through landfill. Land so withdrawn has been used for port facilities including marinas, industrial sites, vacation home sites, and agricultural purposes, among others. Development which involves landfill not only removes valuable estuarine lands from production, but also interferes with productior in other areas through modification of water circulation patterns.

Sedimentation has been a problem in almost all estuaries with identifiable damage to fish life. Erosion in the watersheds, and silting of the estuaries is a natural phenomenon. However, man's activities, chiefly in land use, contribute to the silt loads of streams, thereby accelerating the silting process in estuaries. On the other hand, construction of impoundments on streams tends to reduce silt discharges which sustain coastal features such as sandspits against wave action and thus has led to erosion problems. The effects of upstream land and water uses upon the resouces and values of estuaries have not been clearly established.

However, erosion becomes a problem when it threatens developments or significant natural resources. Out of a total coastal shoreline of 2,837 miles, some 71.3 miles have critical erosion problems while 192.5 miles are subject to noncritical erosion. During the period of historical record, erosion in the State of Washington has been most severe and persistent along the coastline near the estuaries of Willapa Bay and Grays Harbor. In Oregon the spit south of the entrance to Tillamook Bay has been severely eroded.

Local water quality problems cause damage to natural ecological resources in the principal estuaries. Such problems are expected to increase in magnitude and kind with increasing population and industrial development unless adequate countermeasures are adopted. Minimum flows are required in streams to maintain the ecological balance of the estuaries. The amounts of these flows are not known and further studies are needed.

Reclaimed estuarine lands have been used for housing and industrial developments. Demand for landfill for such purposes is expected to increase, particularly for the construction of vacation homes. However, many of the industries and all vacation homes could, without undue penalty, be located on other than estuarine lands. Waterfront locations are, however, essential to certain industries, and estuarine locations for such developments would appear to be justifiable. There is little information available at present as to land requirements of industries which need waterfront locations for their proper functioning.

The needs in estuaries and coastal zones are identified as the protection, preservation, and control of habitat, while at the same time maintaining the values for social and economic pursuits. They differ in some respects from estuary to estuary because of differences in the level of development, and the extent and kind of the resource to be protected. The basic institutional need is to legislate for planning, zoning, and otherwise regulate development and use of estuarine and coastal zones. In addition to enabling legislation, the following is needed:

(1) The immediate preparation and implementation of an interim plan for each estuary and section of coastal zone to regulate developments and protect environmental and scenic values. The plan should include:

(a) The control of the filling of tidelands, marshlands, and submerged lands and structural development in navigable waters.

(b) The safeguarding of important fish and wildlife habitats and their governing ecological parameters.

(c) The evaluation of proposals to dredge or modify navigation channels and for bulkhead, pier, or wharf construction to determine their effects on shoaling, erosion, and water quality.

(2) Investigations, including model studies, to seek solutions to erosion, shoaling, and navigation problems and needs including watershed areas.

(3) Hydraulic studies to:

(a) Determine circulation and tidal transport patterns.

(b) Determine sediment loads, deposition, and scouring both within the estuaries and on the ocean front.

(c) Determine flushing patterns and rates.

(d) Improve understanding of interrelationships between fresh and salt water, including the need for minimum flows.

(4) Biological studies of estuaries to:

(a) Determine fish and wildlife habitat areas of primary importance needed to maintain or increase present population levels.

(b) Determine the relationship of intertidal areas to productivity in open waters of estuaries.

(c) Determine seasonal populations of aquatic flora and fauna of different ecological areas of the ecosystem.

(d) Determine the degree to which finfish, shellfish and crustaceans and their respective food chains depend upon estuarine water.

(e) Determine rates at which oxygen and key species of animals and plants are produced in various ecological areas of estuaries.

(5) Functional studies of estuaries to:

(a) Determine values of estuaries for fish and wildlife resources, scenic features, environmental quality, open spaces, and recreation.

(b) Determine values of estuaries for navigation, urban and industrial development, and other economic activities.

(6) A coordinated integrated plan for the management and use of all estuarine and coastal areas based on the findings of the above studies. This plan would give equal consideration to the values identified in those studies, and would include provisions for the protection of improtant fish and wildlife habitat in conjunction with developmental programs.

Electric Power

The projected electric energy requirements, including necessary reserves, are 18,700 megawatts in 1980, 66,600 megawatts in 2000, and about 170,600 megawatts in 2020. The projected development for capacity is 33,800 megawatts in 1980, 102,300 megawatts in 2000, and 256,900 megawatts in 2020. Up to the present time, power needs have been met almost exclusively with hydroelectric generation. In the future, thermal capacity is expected to carry virtually all of the base load while hydro will be used primarily to meet peak loads. Figures 8 and 9 show the projected loads in terms of energy and capacity.

Providing sufficient rights-of-way for the transmission of large amounts of power presents one of the biggest problems in meeting power loads by year 2000 and beyond. This will be particularly true for the movement of power from east of the Cascade Mountains to load centers on the west side.

The major shift to generation by thermal sources also creates numerous problems. Some major problems are methods of cooling and corresponding treatment of cooling water, disposal of nuclear wastes, radiation hazards, air pollution, and perhaps the greatest of all--public opposition with regard to siting. Resolution of all these problems is necessary if the projected power loads of the region are to be met. Intensive powerplant siting studies on a regionwide basis are an early requirement.

Another problem, this one stemming from hydroelectric sources, is fluctuation in water levels caused by heavy peaking loads. Some studies of downstream effects are underway, but additional information is needed to answer questions on recreation, fish, navigation, and environmental factors.

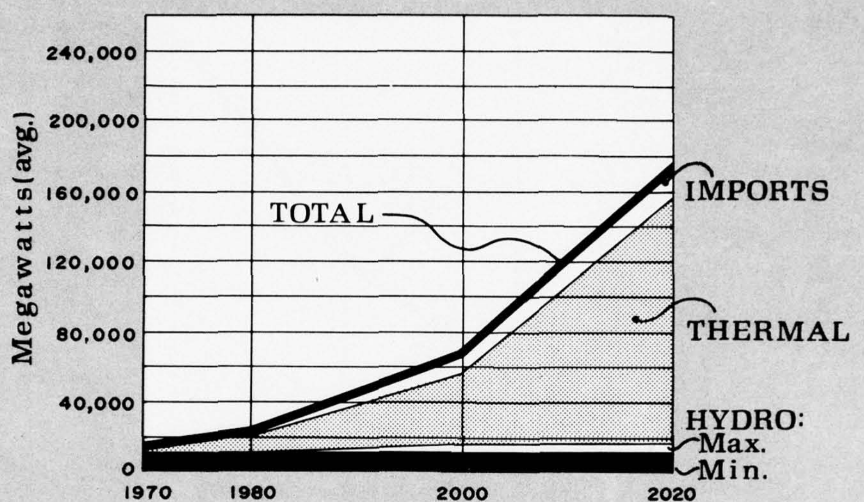

FIGURE 8. Projected Energy Load

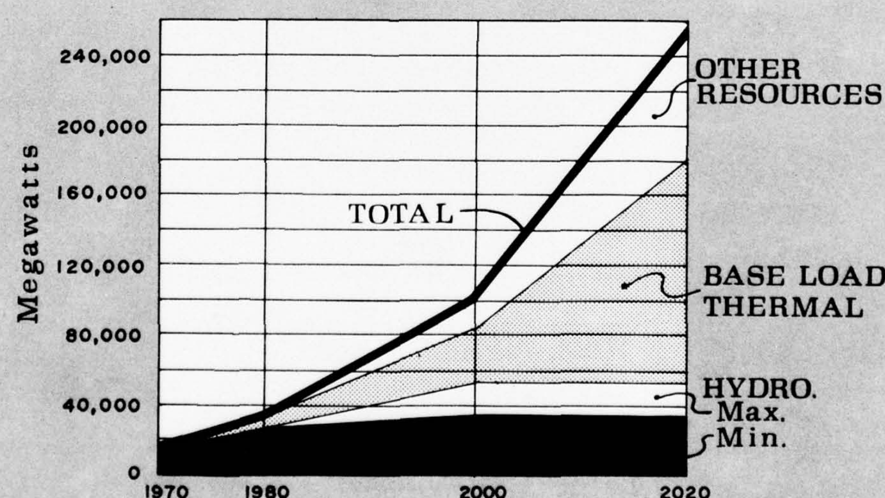

FIGURE 9. Projected Capacity

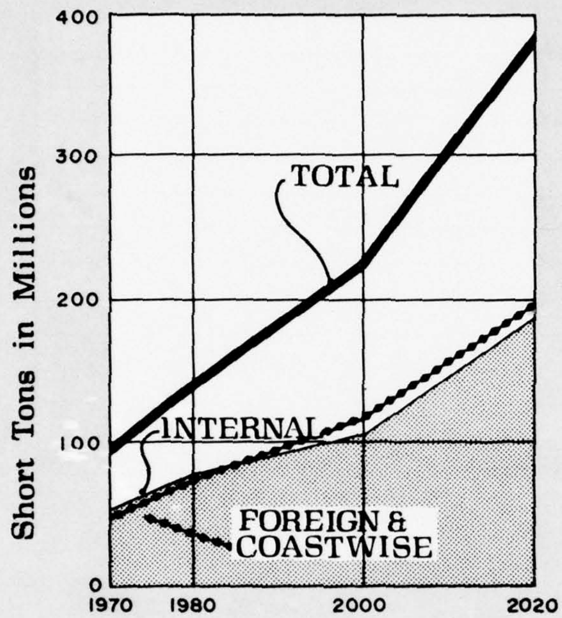

FIGURE 10. Projected Annual Waterborne Commerce

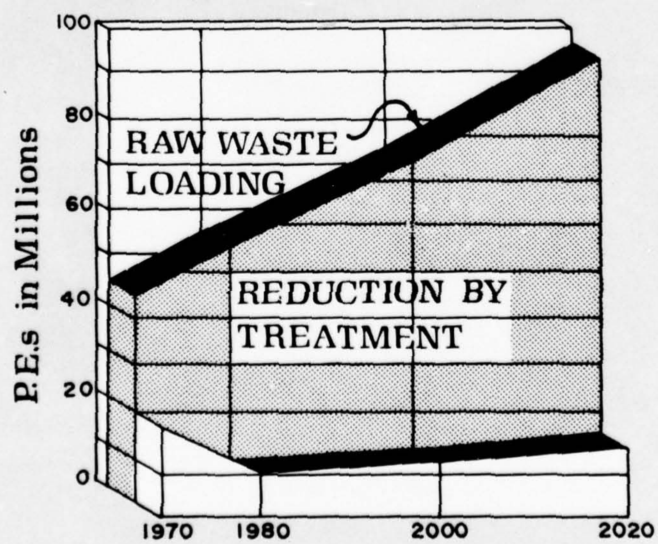

FIGURE 11. Projected Raw Waste Loading; Municipal, Industrial, Recreation, and Rural Domestic Sources

Navigation

As waterborne commerce is related to the economic development of the region, it can be expected that future shipping needs will be governed in many respects by economic production patterns already established in the region. Agricultural and forest products production will continue to be important facets of the region's economy, with continuation of shipping requirements for exporting surpluses to national and world markets. The manufacturing base of the region will expand and diversify with increasing requirements for importation of raw materials and export of finished products. As population expands, petroleum products and other consumer goods must be imported.

Foreign and domestic commerce is forecast to increase from about 45 million tons in 1968, to almost 200 million tons in 2020. Internal commerce is projected to increase from about 52 million tons in 1968, to almost 190 million tons in 2020 (figure 10).

Commerce is forecast to increase from 11.5 million tons in 1968, to 20.1 million tons in 2020 on the Columbia-Snake system, and from 5.3 million tons in 1968, to 13.2 million tons in 2020 on the Willamette waterway.

The number of pleasure boats is projected to increase from 423,000 boats in 1970, to 2,274,000 boats in 2020.

The principal commercial navigation needs are improvements to harbor entrances and the deepening of channels. The need for additional shore facilities would depend on the type of cargo handled and the degree of modernization of port facilities. Through the adoption of improved handling methods, existing port developments may be capable of meeting all ordinary needs of the future. Therefore, the need to withdraw additional estuarine lands for port developments may not arise. However, deeper draft ships of the future will require deeper channels. A regional port study is needed to evaluate the effects that changes in shipping technology will have on commodity movements and to determine future port requirements as well as the means to accommodate these requirements. For recreational boating, there is need to both expand and improve facilities. Existing facilities are overtaxed and additional facilities are needed to keep pace with the dramatic increase in small boat usage.

Water Quality Control

In contrast to conditions in many other parts of the Nation, water quality in the region is still generally very good, with large quantities of relatively unpolluted water available. However, serious pollution problems do exist, resulting in deterioration of the quality of water supplies, damage to sport and commercial fisheries, and undesirable public health and esthetic conditions. Municipal and industrial waste discharges, agricultural return

flows, and improper land use have all been contributing factors.

The projected waste production in population equivalents from municipal, industrial, recreational, and rural domestic sources is estimated to reach about 95 million in 2020 as compared to a population forecast of 15.4 million in 2020 (figure 11). In addition, livestock raw waste production is projected to almost equal the combined total of all other sources.

Water pollution control needs an effective and coordinated regionwide program of waste control and treatment, flow regulation, and land use management. Water quality management must meet the adopted state water quality standards and, for future time periods, also meet projected higher standards.

Waste production needs to be reduced by improved recovery practices in the production process, by reducing the amounts of wastes generated, and by raising the level of treatment. As waste treatment processes to remove all pollutants are limited by costs, the dilution capacity of the receiving waters must be relied on partially for maintenance of quality.

Municipal & Industrial Water Supply

Overall, the region has adequate water supplies for domestic and industrial purposes to meet requirements well into the next century. However, the capacity of some existing sources to satisfy needs at the necessary times and places is questionable.

Municipal water supply problems exist in localized areas of the Columbia Plateau, the Snake River Plain, the Coastal Subregion, and the Oregon Closed Basin. Common problems are excessive depths to the water table and aquifers of low yield. Many areas utilizing surface-water sources experience short-term deficiencies due to seasonal streamflow variation.

Industrial water supply problems are limited and localized in nature. Shortages have curtailed industrial development in certain areas of the Columbia Plateau and the Snake River Plain, and some places have experienced seasonal streamflow deficiencies.

From the standpoint of municipal and industrial requirements, there are few serious water quality problems. There are scattered reaches of the Clark Fork, Snake, and Silvies Rivers that display high coliform counts, generally during low summer flows, but this water responds to treatment and is still usable. Turbidity, associated with high winter flows, is a problem in areas of the Puget Sound, Coastal, and Mid Columbia Subregions.

Rural-domestic water quality problems occur in all areas. Shallow wells may become contaminated, yet deep wells may be beyond the individual's

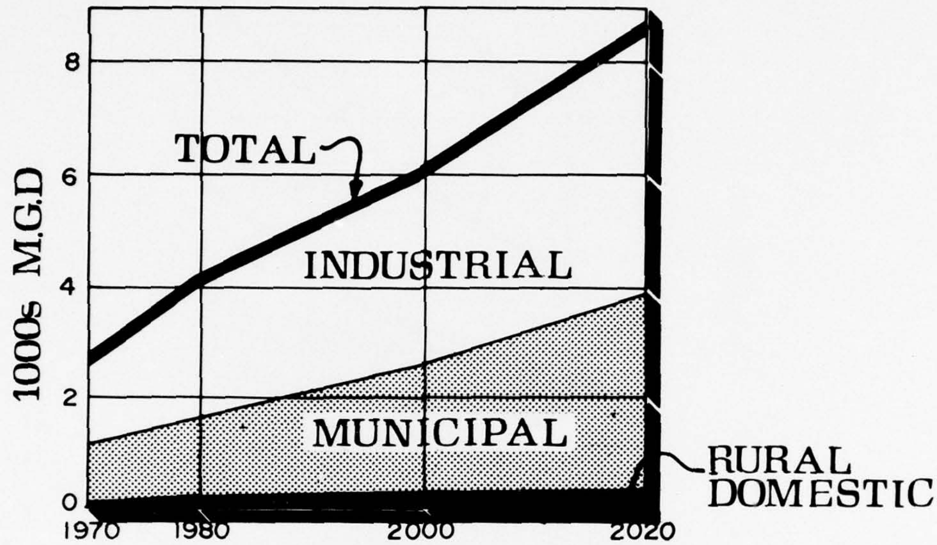

FIGURE 12. Municipal and Industrial Water Requirements

financial ability to develop. Most surface waters have turbidities which limit their use by rural communities.

Water use is projected to increase to 4,300 mgd by 1980, 6,400 mgd by 2000, and nearly 9,000 mgd by 2020, a total increase in 2020 of about three times the 1970 use (figure 12).

Flood Control

The flood plains of the major streams and tributaries, which total nearly 1.6 million acres, range from brushy marshlands to business and residential districts.

Major damages are encountered on several of the larger streams flowing into Puget Sound and in the Rogue and Umpqua River Basins. The more serious problems in the Willamette Basin and along the Columbia River below Bonneville Dam have been relieved by existing and under construction structural measures. Major flood control projects reduce the total average annual damages in the region by approximately $70 million.

When all projects now underway are completed, more than 43.5 million acre-feet of joint-use storage space will be available on a forecast basis for control of the Columbia River spring floods.

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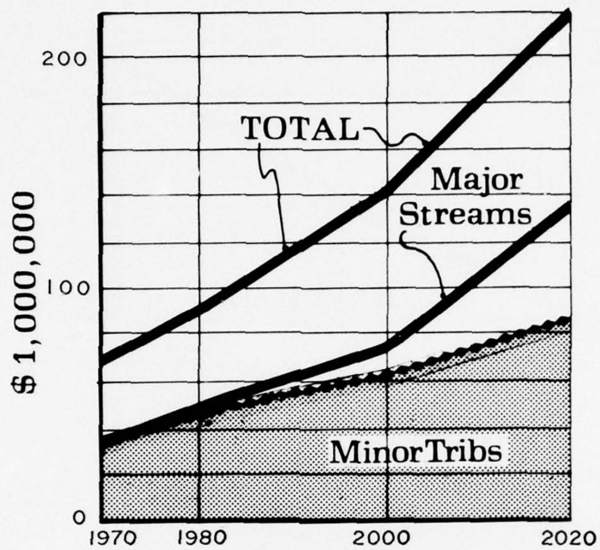


FIGURE 13. Projected Average Annual Flood Damages

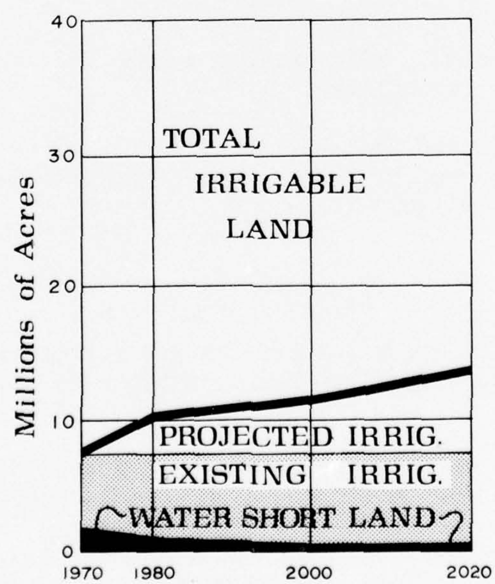


FIGURE 14. Projected Irrigation Requirements

The Willamette River, which flows through the highly developed Willamette Valley, has caused millions of dollars of damages. Multiple-purpose reservoirs constructed in this drainage system provide 1,810,000 acre-feet flood control storage.

In 1967, the average annual flood damages by major streams and principal tributaries were estimated to be about $34 million. The average annual damages are projected to increase to about $46 million in 1980, $75 million in 2000, and $134 million in 2020. These projections assume that future land use will closely follow existing patterns and that flood damages will be proportional to total development in the flood plains.

In addition, 2.3 million acres are flooded by minor tributaries and onfarm flows causing damages estimated at nearly $36 million annually. These damages are projected to increase to $84 million by 2020 (figure 13).

Irrigation

In 1970, about 7.5 million acres were irrigated, roughly a third of the cropland. The Snake River Basin alone accounts for over 50 percent of the total. About one-fourth of the irrigated land experiences late season water shortages. There still remain some 33 million dry land acres suitable for irrigation. Over 40 percent of this potentially irrigable land is class 1 or 2, capable of producting high yields of all climatically adapted crops.

The region's allocated share of projected national food and fiber needs is based on OBERS projections of March 1968. Taking into account expected yield improvement from both dry and irrigated lands, an estimated 6.0 million acres of new irrigation and a supplemental water supply for an estimated 2 million acres will be required by 2020. The irrigation requirement (figure 14) was apportioned among the subregions by considering the location of potentially irrigable lands, available water supplies, historic trends, present levels of irrigation development and production, and competitive demands for use of land and water resources.

To irrigate the new lands needed by 2020 and provide supplemental supplies to water-short lands, annual diversions would need to be increased 65 percent--from 33.7 million acre-feet in 1970 to 57.3 million acre-feet by 2020. Improved water use efficiencies were assumed in arriving at the diversion requirement.

By 2020, total depletions for irrigation are expected to be about 29.2 million acre-feet annually, an increase of 13.4 million acre-feet over the 1970 level.

Fish and Wildlife

Fish and wildlife resources of anadromous fish, resident fish, marine fish, and shellfish, big game, upland game, fur animals, waterfowl, and other wildlife, are significant to man's enjoyment and to the economy. The annual hunting and angler days were estimated at about 32 million for 1970. The economic value of both the sports and commercial fish and wildlife activities approximated a quarter of a billion dollars in that year. The sport fishing and hunting demand is expected to increase 154 percent and 112 percent, respectively, by 2020 (figure 15). The demand for commercial fishing is expected to almost double.

The Columbia River system has historically been one of the world's largest producers of anadromous fish. However, impoundments on the Columbia River and its tributaries have inundated large areas of spawning habitat and in some cases blocked upstream migrations and inhibited successful downstream migrations of juveniles. Fish passage facilities and a system of 76 hatcheries are being operated in the region to preserve and enhance the remaining resource.

In recent years, a new and previously unforeseen problem has developed. Large numbers of juvenile and adult fish have been killed by air embolism similar to the bends suffered by human divers. The problem is aggravated by water becoming nitrogen supersaturated from air entrained when water is passed over spillways. The problem is widespread throughout the Columbia River below Chief Joseph Dam and along the lower Snake River.

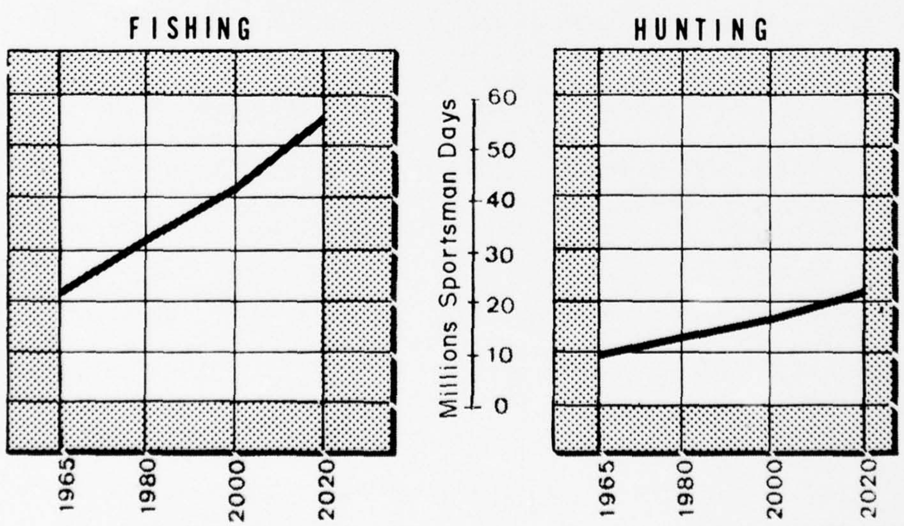


FIGURE 15. Projected Sport Fishing and Hunting Needs

Considerable research and study are needed to accurately evaluate needs for these resources. Better guides are needed to determine fish and wildlife populations required relative to man's needs, and to translate those results into requirements for habitat protection and improvement. Additional standards and guidelines are seriously needed to develop quantitative support data for fish and wildlife resources which will assure their equal consideration with other natural resources in future planning and development efforts.

Additional legislation to further fish and wildlife conservation and enhancement is also needed. To insure future hunting, fishing, and esthetic enjoyment, fish and wildlife must be given the equal consideration afforded other project-affected interests.

Recreation

Many of the Nation's most varied and outstanding natural outdoor recreation attractions are found in the region. These include over 2.5 million acres of water surface; nearly 10,000 miles of potential wild, scenic, and free-flowing rivers; over 2,800 miles of ocean, Puget Sound, and estuary shoreline; and more than 20 million acres of special recreation attraction. With about 60 percent of the land area in public ownership, most will continue to be available for outdoor recreation purposes for the foreseeable future.

Outdoor recreation use now exceeds 200 million recreation days, of which over 89 million recreation days are involved directly in water-related activities. As shown in figure 16, projections indicate that water-related recreation would reach a gross demand of 139 million recreation days in 1980, 272 million in 2000, and 511 million in 2020.

The overriding problem associated with outdoor recreation resources is that of achieving a proper balance between their use and their protection. This involves (1) competition for water-related lands, (2) preservation of free-flowing streams, (3) competition between recreation uses, (4) overuse, misuse, vandalism, and pollution, (5) unsatisfactory distribution of recreation sites between urban and rural areas, and (6) financing.

Two basic programs are needed. The first involves keeping existing resources available for outdoor recreation use. This will require the preservation and maintenance of existing supply, including areas presently managed as wilderness and national parks, free-flowing rivers, and other public use areas. The second relates to the development of recreation resources within their capacities to support both the resident population and increase tourist use. This will require both the development of existing areas to their full carrying capacity and the addition of new areas as the needs arise. Adequate supplies of land and water are available to meet

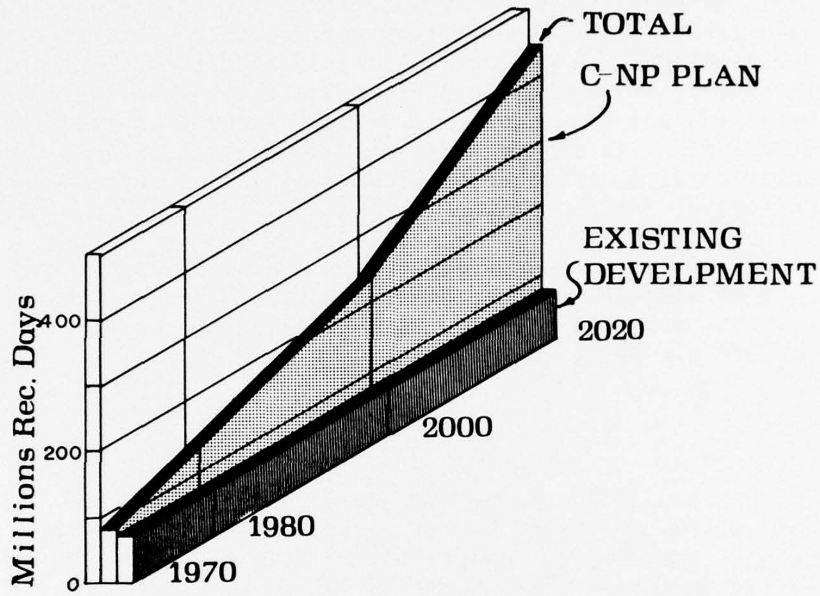


FIGURE 16. Water-Related Outdoor Recreation Needs

projected needs. However, location and accessibility of the supply are not always optimum. Land requirements include associated land needed for camping, picnicking, swimming beaches, boat launching and parking, etc. as well as the unoccupied buffer zone or landscape area. In addition to the requirements for developed recreation sites, is the need for undeveloped areas. Every effort should be made to set aside unique features of the landscape. The more interesting natural, archeological, and historical areas should be identified, classified, protected, and interpreted through both Federal and State systems.

Related Land

The region includes 173.7 million acres of land and 1.9 million acres of large water areas. About 86 million acres of forests cover 49 percent of the region's total land area. Rangeland is next, occupying about 59 million acres or 34 percent. Cropland amounts to 21 million acres, 12 percent, and other land comprises more than 8 million acres, or 5 percent of the regional area.

Forest land is projected to decrease slightly to 84.1 million acres by 2020. Forest and wood-using industries are estimated to require nearly 5.3 billion cubic feet of raw material per year by the year 2020, a substantial

increase over the present regional consumptive rate of 4.3 billion cubic feet per year.

Rangeland is projected to decrease from 58.7 million acres to 56.5 million by 2020. Considerable acreage now used for rangeland will likely be diverted to cropland, urban, and other land uses.

Cropland acreages are projected to increase by 4 percent from 1966 to 2020 while food and fiber needs will more than double. This increase should be accompanied by more intensive use, improved management, increased production, and additional irrigation. About 51 million acres of land have been classified suitable for crop production, so that considerable opportunity exists for expansion of agricultural production.

The acreages devoted to other land uses are projected to increase more than 2.0 million acres to 10.5 million acres by 2020 (table 11). Projections indicate that the larger population will require an additional 709,000 acres for urban, industrial, farmsteads, airports, and similar uses by 2020. Projected changes in land use are illustrated graphically in figure 17.

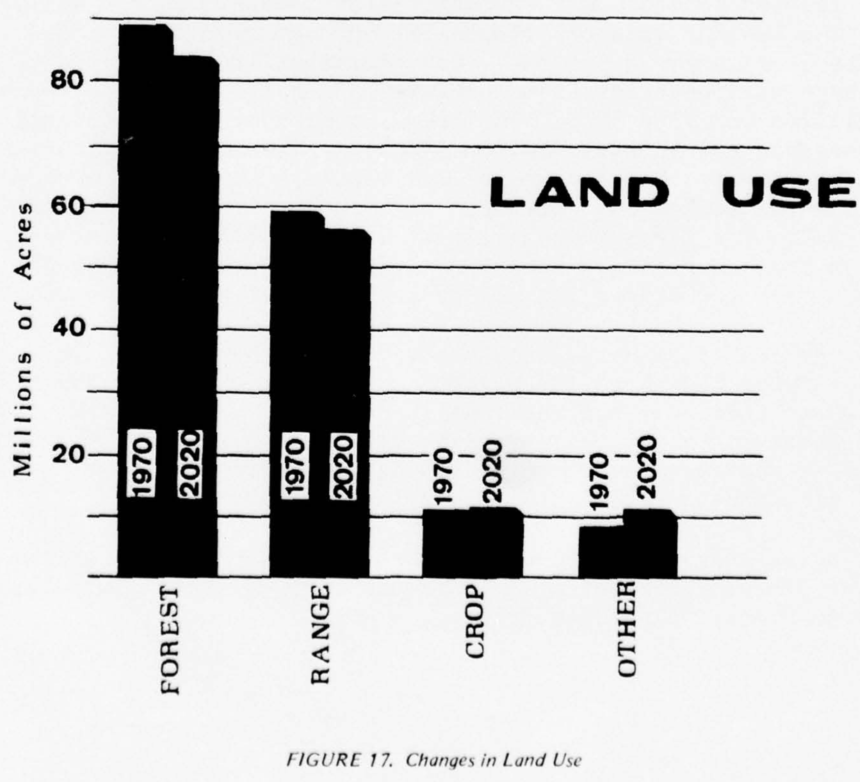


FIGURE 17. Changes in Land Use

SUMMARY

The water and related resource needs which were derived in preceding sections are summarized in table 12. This summary gives the estimated current development, gross needs for 1980, 2000, and 2020, and reduces the gross needs for the current development to derive the residual needs.

Electric power exhibits the highest rate of projected growth, rising to nearly 12 times the current development or almost 257,000 MW of capacity and 1,286,000 million kilowatt hours of energy by 2020. A comparison of the projected growth of electric power with the projected population growth of 2.4 times the current level over the same period indicates the magnitude of anticipated electric power demands.

The rate of growth in needs for recreation development and pleasure boating increases much faster than population, reaching more than 5 times the current level by 2020. This reflects, to some extent, the attractiveness of the region's natural environment and the increased affluence of its people. The needs for sports fishing and hunting follow closely the forecast growth of population.

Agriculture plays a dominant role because of the tremendous size of its water and related land needs. Projections of crop production by 2020 are about 2.4 times the current rate of production, but the cropland acreage is only expected to increase by 4 percent. Consequently, irrigated land is forecast to increase by 6 million acres from the current 7.5 million acres reaching a total of 13.5 million acres by 2020. The need for management of the watersheds exhibits sizable growth patterns, particularly in bank stabilization and in channel alterations. These measures are elements which have been deferred in the past and the longer they are held off, the greater the need becomes. Flood damages represent a large monetary loss, both on major streams and on tributaries. This demonstrates a requirement for management and regulation of the flood plains and for structural measures where justified.

Navigation needs, expressed in terms of commerce, picture the growing importance of the region in the markets of the world and the increased use of low-cost water transport for internal movements of commodities. The need for municipal water reflects the increasing water demands of urban living. The lower rate of raw waste and treated discharges indicates recycling and higher levels of treatment.

In perspective, these needs represent a cross section of the future of the region. The development of a framework plan to meet needs will provide a usable guide for planning this future.

Table 12—Needs Summary
Columbia-North Pacific Region

Purpose or Function	Units	Current (1970) Development	Projected Gross Needs 1980	Projected Gross Needs 2000	Projected Gross Needs 2020	Residual Needs 1980	Residual Needs 2000	Residual Needs 2020
Water Development and Control								
Electric Power								
Capacity (Peak)[1]	mw	21,526	33,800	102,300	256,900	12,274	80,774	235,374
Energy[1]	mil kwh	102,641	193,200	512,000	1,286,000	90,559	409,359	1,183,359
Navigation								
Commerce	1,000 tons	97,580	144,500	229,100	390,300	46,920	131,520	292,720
Water Quality Control								
Raw Waste Production[2]	1,000 p.e.	44,520	54,791	73,613	95,382	10,271	29,093	50,862
Waste Removal[2]	1,000 p.e.	24,559	43,593	60,527	79,001	19,034	35,968	54,442
Municipal and Industrial Water								
Supply	mgd	3,129	4,181	6,153	8,624	1,052	3,024	5,495
Municipal	mgd	(1,008)	(1,433)	(2,198)	(3,414)	(425)	(1,190)	(2,406)
Industrial	mgd	(1,911)	(2,499)	(3,641)	(4,823)	(588)	(1,730)	(2,912)
Rural-domestic	mgd	(210)	(249)	(314)	(387)	(39)	(104)	(177)
Flood Damages								
Major Streams[3]	Ann. $1,000	26,546	-	-	-	38,333	66,709	123,964
Bank Erosion[3]	Ann. $1,000	7,453	-	-	-	8,186	9,594	11,292
Area Flooded[3]	1,000 ac	1,617	-	-	-	1,617	1,617	1,617
Irrigation								
Total Irrigated Area	1,000 ac	7,503	10,098	11,396	13,503	2,595	3,893	6,000
Water Short Area	1,000 ac	(1,970)	-	-	-	(1,970)	(1,970)	(1,970)
Water Supply	1,000 ac-ft	33,739	45,814	50,119	57,308	12,075	16,380	23,569
Water and Related Land Programs								
Fish and Wildlife								
Commercial Fishery	1,000 lbs	183,441	269,753	357,230	466,671	86,312	173,789	283,230
Sport Fishing	1,000 days	21,346	32,223	45,418	64,146	10,877	24,072	42,800
Resident Species	1,000 days	(14,527)	(21,189)	(29,571)	(41,487)	(6,662)	(15,044)	(26,960)
Anadromous, Marine, Shell	1,000 days	(6,819)	(11,034)	(15,847)	(22,659)	(4,215)	(9,028)	(15,840)
Hunting	1,000 days	10,504	13,521	18,461	23,622	3,017	7,957	13,118
Water Related Recreation								
Development	1,000 rec days	89,300	139,200	271,500	511,200	49,900	182,200	421,900
Required Surface Water Use[4]	acres	367,900	536,800	1,016,400	1,870,300	168,900	648,500	1,502,400
Land Area (Rec. Facility Develop.)	acres	30,700	76,200	130,000	239,600	45,500	99,300	208,900
Pleasure Craft	no. (1,000s)	423	619	1,182	2,210	196	759	1,787
Watershed Management								
Flood Damages—Minor Streams[3]	Ann. $1,000	35,803	-	-	-	46,525	62,089	83,992
Area Flooded[3]	1,000 ac	2,308	-	-	-	2,308	2,308	2,308
Erosion and Sediment Control	1,000 ac	15,282	23,187	35,482	47,351	7,905	20,200	32,069
Drainage	1,000 ac	905	1,285	1,764	2,252	380	859	1,347
Beach Erosion Control	miles	-	-	-	-	227	227	227
Bank Stabilization	miles	2,256	6,799	13,832	19,372	4,543	11,576	17,116
Levees and Floodwalls	miles	964	2,067	3,633	5,253	1,103	2,669	4,289
Channel Improvement	miles	5,290	13,723	24,345	33,815	8,433	19,055	28,525
Protection and Management[5]	1,000 ac	120,255	130,277	132,131	132,910	95,744	97,596	98,614
Water Conservation	1,000 ac	7,139	9,827	11,079	13,142	2,688	3,940	6,003
Water Yield Improvement	1,000 ac	0	117	349	612	117	349	612
Related Land Production								
Croplands	1,000 tons	29,722	41,271	54,252	71,606	11,549	24,530	41,884
Irrigation	1,000 tons	(21,140)	(32,010)	(45,135)	(63,537)	(10,870)	(23,995)	(42,397)
Dryland	1,000 tons	(8,582)	(9,261)	(9,117)	(8,069)	(679)	(535)	(-513)
Forest Wood Fiber	mil cu ft	4,227	4,597	5,179	5,298	370	952	1,071
Range Grazing Capacity	1,000 aum	7,269	8,454	10,396	11,824	1,185	3,127	4,555

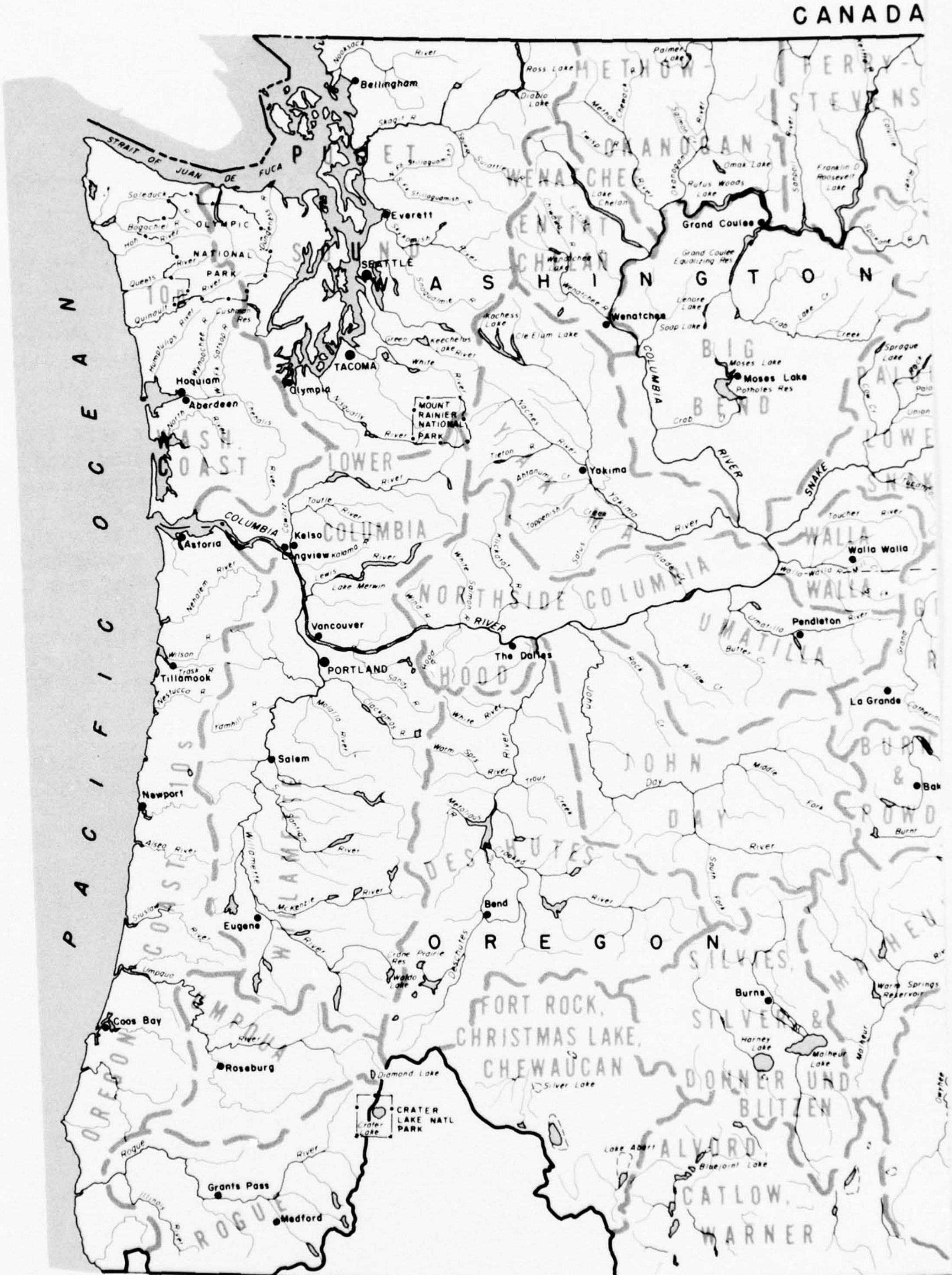
1/ 1970 development and loads assuming critical water year.
2/ Includes municipal, industrial, and recreation use.
3/ Needs over 1970 level of flood prevention
4/ Needs are a function of recreation day requirements.
5/ Includes recurrent programs that will require acceleration with implementation of a plan. Residual needs cannot be determined by subtracting current development from gross needs as many of these practices are applied annually on the same areas.

FORMULATION OF PLANS AND PROGRAMS

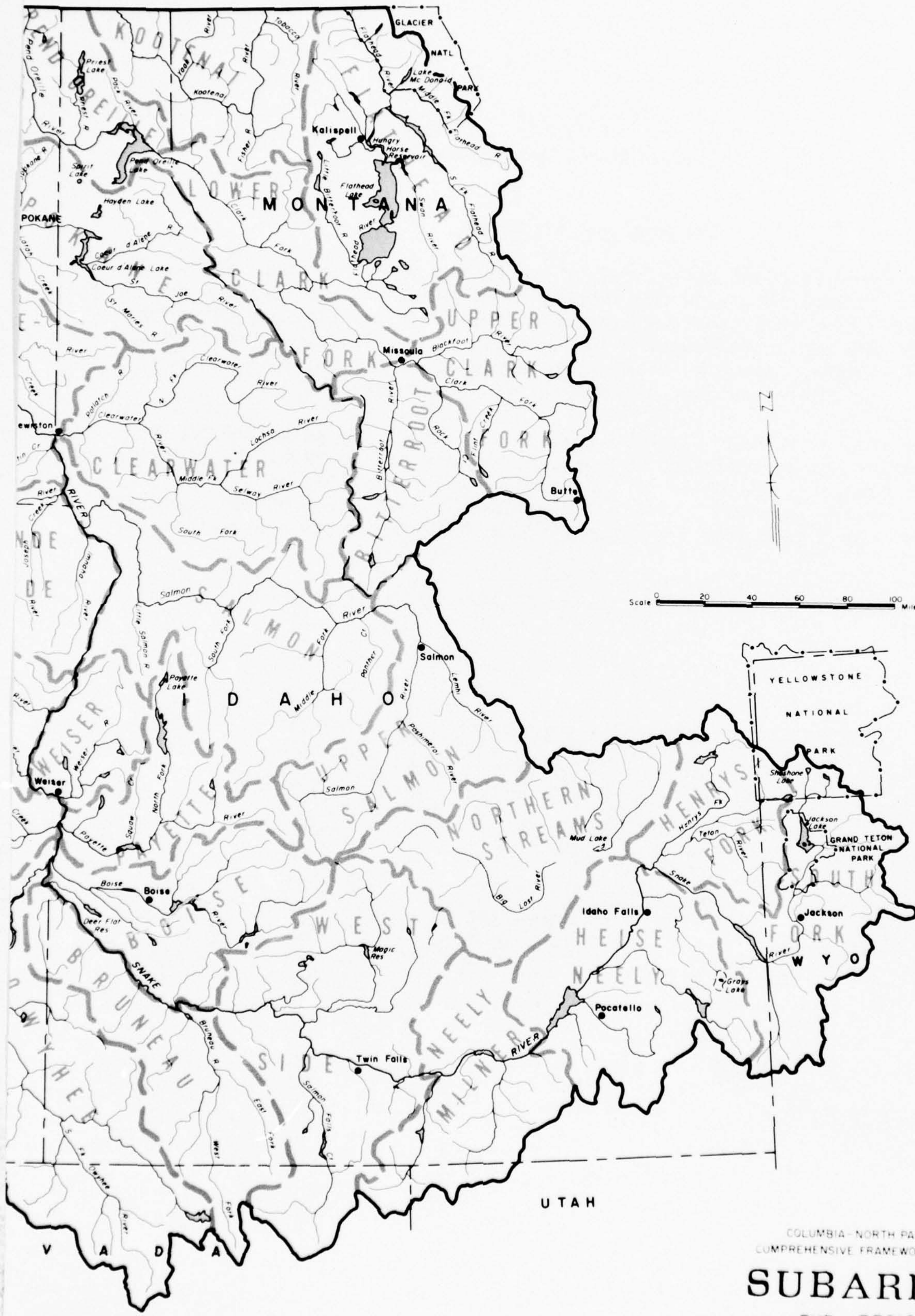
The framework for the four areas and the region is, for the most part, a consolidation of plans and programs formulated for individual river basins or subareas. Thus, the results of plan formulation for these smaller hydrologic areas were generally the building blocks of the regional framework plan (figure 18). Local or area problems and opportunities were examined, alternative plans and programs were evaluated and compared, and the framework plan evolved.

Some elements of the framework plans and programs were found to be common to most subareas or river basins. Water and related land resources are available to meet the needs for municipal and industrial water supply, recreation, fish, and wildlife. Planned waste treatment would remove 85 percent of organic materials by 1980 and 90 percent by the years 2000 and 2020. Watershed treatment, both structural and nonstructural, would be established and maintained throughout the region to relieve problems of erosion, flooding, and drainage, and to conserve water. Minimum flows in all streams are essential to satisfy instream uses including fish, wildlife, water quality, and esthetics. Flood plain regulations are required in all but seven counties of the region. Recognition must also be made of the Indian water rights and full consideration given to them in any plan.

The following describes planning of individual areas, including the reasoning leading to the selection of the framework plans and programs.


CANADA
PACIFIC OCEAN
STRAIT OF JUAN DE FUCA
WASHINGTON
OREGON
Bellingham
Everett
SEATTLE
TACOMA
Olympia
Hoquiam
Aberdeen
Astoria
Kelso
Longview
Vancouver
PORTLAND
The Dalles
Yakima
Wenatchee
Grand Coulee
Moses Lake
Walla Walla
Pendleton
La Grande
Tillamook
Newport
Salem
Eugene
Bend
Burns
Coos Bay
Roseburg
Grants Pass
Medford
OLYMPIC NATIONAL PARK
MOUNT RAINIER NATIONAL PARK
CRATER LAKE NATL PARK
COLUMBIA
RIVER
SNAKE
PUGET SOUND
METHOW
OKANOGAN
WENATCHEE
ENTIAT
CHELAN
BIG BEND
WASH. COAST
LOWER COLUMBIA
NORTHSIDE COLUMBIA
YAKIMA
WALLA WALLA
UMATILLA
HOOD
JOHN DAY
DESCHUTES
WILLAMETTE
UMPQUA
ROGUE
OREGON COAST
FORT ROCK, CHRISTMAS LAKE, CHEWAUCAN
SILVIES, SILVER & DONNER UND BLITZEN
ALVORD, CATLOW, WARNER
Grand Coulee Equalizing Res
Potholes Res
Franklin D. Roosevelt Lake
Ross Lake
Diamond Lake
Silver Lake
Lake Abert
Harney Lake
Malheur Lake
Warm Springs Reservoir
Crater Lake
Lake Merwin

N



COLUMBIA - NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

SUBAREAS

THE REGION

1968

FIGURE 18

AREA A
UPPER COLUMBIA RIVER, SUBREGIONS 1, 2, & 3

The Area and Its Needs

The Upper Columbia River Area, shown in figure 19, includes the watershed of the Columbia River in the United States above its confluence with the Snake River. It covers 64,875 square miles lying between the Cascade Range on the west and the Rocky Mountains on the east in the States of Washington, Idaho, and Montana. Between these mountain ranges is the Columbia Plateau, a relatively flat tableland that slopes gently southwestward.

The area's two most highly developed aspects of the water and related land resources are hydroelectric power and irrigation. By 1970, the electric generating capacity, installed or under construction, totaled about 12,000 megawatts, mostly in seven Columbia River plants. Irrigation of approximately 1.7 million acres accounted for about 95 percent of the total consumptive use of water.

The water and related land resource needs of the area are summarized in table 13.

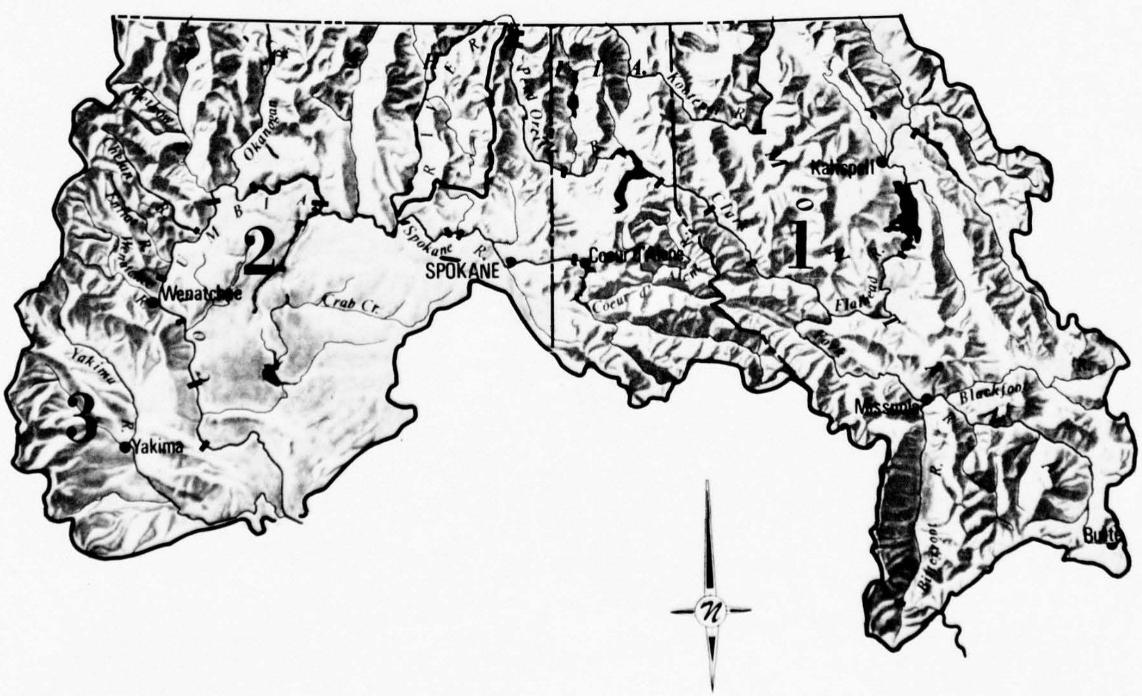


FIGURE 19. Plan Formulation Area A

Table 13—Needs Summary, Area A
Columbia-North Pacific Region

Purpose or Function	Units	Current (1970) Development	Projected Gross Needs 1980	2000	2020	Residual Needs 1980	2000	2020
Water Development and Control								
Electric Power								
Capacity (Peak)	mw	Projected on a Regional Basis Only						
Energy	mil. kwh	Projected on a Regional Basis Only						
Navigation								
Commerce	1,000 tons	170	4,300	6,000	7,800	4,130	5,830	7,630
Water Quality Control								
Raw Waste Production 1/	1,000 p.e.	4,461	6,550	9,882	14,444	2,089	5,421	9,983
Waste Removal 1/	1,000 p.e.	3,927	5,567	8,894	13,000	1,640	4,967	9,073
Municipal and Industrial Water								
Supply	mgd	507	624	841	1,106	117	334	599
Municipal	mgd	(209)	(261)	(386)	(546)	(52)	(177)	(337)
Industrial	mgd	(236)	(291)	(366)	(451)	(55)	(130)	(215)
Rural-domestic	mgd	(62)	(72)	(89)	(109)	(10)	(27)	(47)
Flood Damages								
Major Streams 2/	Ann. $1,000	3,510	-	-	-	5,468	10,422	20,960
Bank Erosion 2/	Ann. $1,000	668	-	-	-	886	1,119	1,583
Area Flooded 2/	1,000 acres	200	-	-	-	200	200	200
Irrigation								
Total Irrigated Area	1,000 acres	1,843	2,690	3,010	3,850	847	1,167	2,007
Water Short Area	1,000 acres	(338)	-	-	-	(338)	(338)	(338)
Water Supply	1,000 ac-ft	8,203	11,892	13,315	16,182	3,689	5,112	7,979
Water and Related Land Programs								
Fish and Wildlife								
Commercial Fishery	1,000 lbs.	0	0	0	0	0	0	0
Sport Fishing	1,000 days	5,037	7,024	9,314	12,130	1,987	4,277	7,093
Resident Species	1,000 days	(4,967)	(6,904)	(9,154)	(11,920)	(1,937)	(4,187)	(6,953)
Anadromous, Marine, Shell	1,000 days	(70)	(120)	(160)	(210)	(50)	(90)	(140)
Hunting	1,000 days	2,813	3,465	4,567	5,918	652	1,754	3,105
Water Related Recreation								
Development	1,000 rec. days	15,900	23,600	44,300	81,300	7,700	28,400	65,400
Required Surface Water Use 3/	acres	67,300	80,200	148,800	274,200	12,900	81,500	206,900
Land Area (Rec. Facility Develop.)	acres	8,700	15,700	23,300	40,800	7,000	14,600	32,100
Pleasure Craft	no. 1,000s	72	83	155	284	11	83	212
Watershed Management								
Flood Damages—Minor Streams 2/	Ann. $1,000	5,217	-	-	-	6,358	7,509	8,714
Area Flooded 2/	1,000	387	-	-	-	387	387	387
Erosion and Sediment Control	1,000	3,652	5,137	7,977	10,171	1,485	4,325	6,519
Drainage	1,000	191	245	334	417	54	143	226
Beach Erosion Control	miles	-	-	-	-	0	0	0
Bank Stabilization	miles	608	2,147	3,966	5,296	1,539	3,358	4,688
Levees and Floodwalls	miles	74	228	376	493	154	302	419
Channel Improvement	miles	1,741	4,381	7,690	10,941	2,640	5,949	9,200
Protection and Management 4/	1,000	28,624	29,275	29,974	30,605	26,007	26,706	27,539
Water Conservation	1,000	1,662	2,611	2,926	3,738	949	1,264	2,076
Water Yield Improvement	1,000	0	52	147	244	52	147	244
Related Land Production								
Crop	1,000 tons	9,332	13,991	18,643	24,641	4,659	9,311	15,309
Irrigation	1,000 tons	(6,675)	(10,681)	(15,701)	(23,606)	(4,006)	(9,026)	(16,931)
Dryland	1,000 tons	(2,657)	(3,310)	(2,942)	(1,035)	(653)	(285)	(-1,622)
Forest Wood Fiber	mil. cu. ft.	632	703	791	818	71	159	186
Range Grazing Capacity	1,000 aum	1,031	1,101	1,435	1,585	70	404	554

1/ Includes municipal, industrial, and recreational use.
2/ Needs over 1970 level of flood prevention.
3/ Needs are a function of recreation-day requirements.
4/ Includes recurrent programs that will require acceleration with implementation of a plan. Residual needs cannot be determined by subtracting current development from gross needs as many of these practices are applied annually on the same areas.

Formulation of Area Plans and Programs

The Upper Columbia River Area has a wide range of opportunities to meet water and related land resource needs. However, possible conflicts between objectives required the consideration of several major alternatives. These problems, the alternatives considered, and the plan or program evolved, together with the reasons for the selected course of action, are described by the various basins or subareas.

All water rights in this area must be considered in planning, including those of the Flathead, Coeur d'Alene, Kalispel, Kootenai, Spokane, Colville, and Yakima Indian Reservations, and the Chelan allotments.

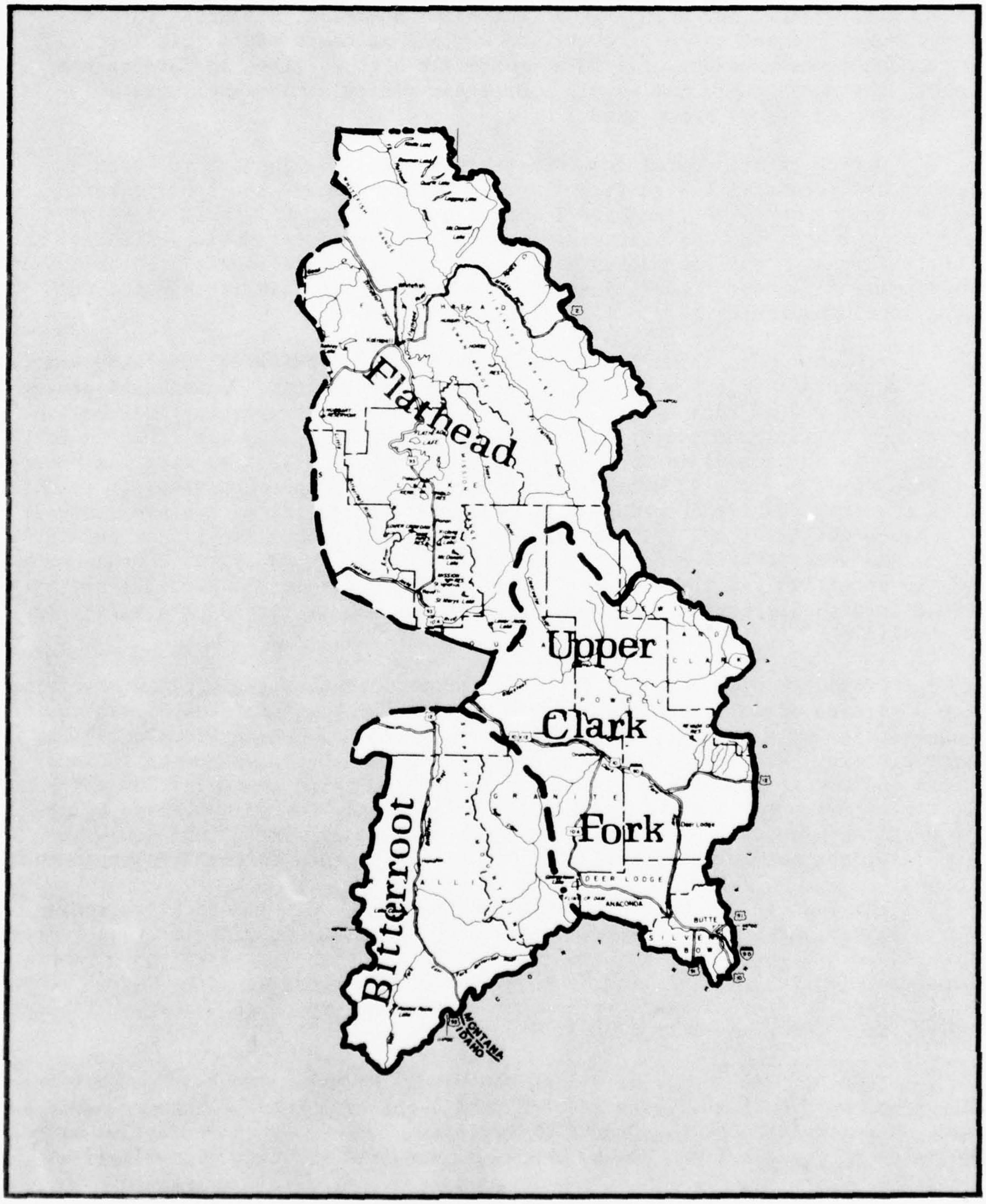
The Idaho Water Resources Board requested that the following statement be included for the Idaho portion of this area: *"A comprehensive plan has not evolved for the State of Idaho. The Idaho Water Resource Board, representing the State of Idaho in water resources planning functions, determined that a full comprehensive water resources plan for the state should not be fixed at this time. Many ongoing studies, such as Joint State Wild and Scenic Rivers Study, USDA Type IV Studies, the Western United States Reconnaissance Study, and the Columbia River Tributary Study will provide additional information on resource use. Therefore, Idaho has elected to delay formulation of a plan, however, alternatives have been identified and, where possible, studies have been outlined that would resolve conflicts and/or would assist in the selection of a plan between competing uses."* The use of the word "planned" in this document does not imply that a fixed plan has been developed.

Upper Clark Fork Subarea (Subregion 1)

The Upper Clark Fork Subarea is comprised of the Clark Fork and Blackfoot Rivers above their confluence. It is an area that lacks a dependable water supply for irrigation during the summer low-flow period, but has some flooding during the spring and early summer. There are a number of streams with significant scenic, recreational, and sport fishing values.

Minor flooding occurs along the Clark Fork and some of its tributaries. Recurrent flood damages are most prevalent at Deer Lodge and on the Blackfoot River near Lincoln. Watershed treatment needs result primarily from poor drainage, steep or irregular topography, flooding, and erosion. About 131,000 acres were irrigated in 1970 of which 18,000 acres need supplemental water. An additional 296,000 acres are potentially irrigable. However, most of the potentially irrigable lands are on higher plateaus near headwater areas where water supplies are limited.

The 20-mile reach of the upper Clark Fork from Butte to Warm Springs, which includes Silver Bow Creek, is completely devoid of dissolved oxygen as a result of its use to transport mining, refining, and milling wastes to a


Flathead
Upper
Clark
Fork
Bitterroot
DEER LODGE
ANACONDA
BUTTE
MONTANA
IDAHO

treatment lagoon at Warm Springs. Anaconda Copper Co. has recently begun to treat mill wastes, and discharge of untreated municipal effluents into the Clark Fork is expected to be curtailed by 1972 in conformance with the State water quality standards. Coliform counts are high at times in Rattlesnake Creek, the municipal water supply source for Missoula. However, the water is fully treated before being used.

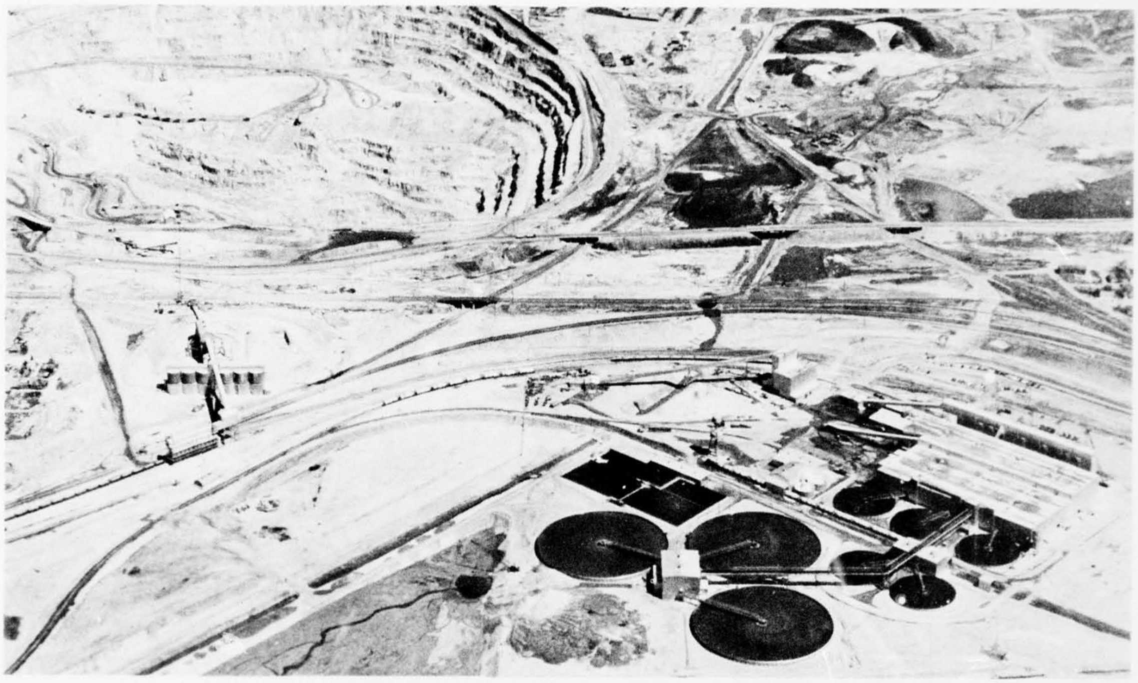
Direct environmental considerations in plan development included a number of streams with significant scenic, recreational, and sport fishing values which should be recognized; the need for additional facilities for camping, picnicking, and hiking; access to additional recreation, fishing, and hunting areas; and preservation of streams and historical areas. Establishment of minimum flows for fisheries and the acquisition of wildlife habitat are additional requirements.

A number of alternatives to improve water control were examined, some of which would conflict with environmental considerations. Interbasin diversion of water from Rock Creek, Flint Creek, and other drainages could be developed to irrigate additional lands. However, depleting the flows in Rock Creek could be harmful to the highly valued fishery; diversion from the other streams would be costly, provide limited development opportunities, or conflict with existing fishing opportunities. Numerous storage sites are available on the Blackfoot River and tributaries for irrigation, recreation, flow augmentation, and some minor hydropower development. However, the sites contain much of the potentially irrigable area. A site on the Little Blackfoot River that could furnish irrigation water was rejected because of its adverse effect on fish life.

Framework plan measures for flood control include flood plain regulation, the diversion of Cottonwood Creek into Johnson Creek at Deer Lodge, and the construction of a levee to close the overflow channel on the Blackfoot River near Lincoln. Watershed treatment projects would be carried out at 18 locations and forest land treatment at six locations. With about 111,000 acre-feet of storage in small headwater reservoirs, water for 73,000 acres of new land and supplemental water for 18,000 acres now under irrigation could be supplied, and sufficient water would be left in streams to meet fishery needs.

The industrial waterway classification of the Clark Fork River above Warm Springs and Silver Bow Creek should be rescinded and mine and mill wastes treated to meet State water quality standards. Pending installation of these treatment facilities, existing dikes at the Warm Springs settling lagoon would be improved to prevent overtopping. Existing mine wastes in the upper Blackfoot Valley would be removed or neutralized.

Scenic roads should be designated along Interstate 90 on the Clark Fork River and on U.S. 10A between Anaconda and Georgetown Lake. A study should be made on designation of the Blackfoot River and Rock Creek as recreation streams. Wetlands in the Blackfoot Valley should be acquired or leased for waterfowl nesting.



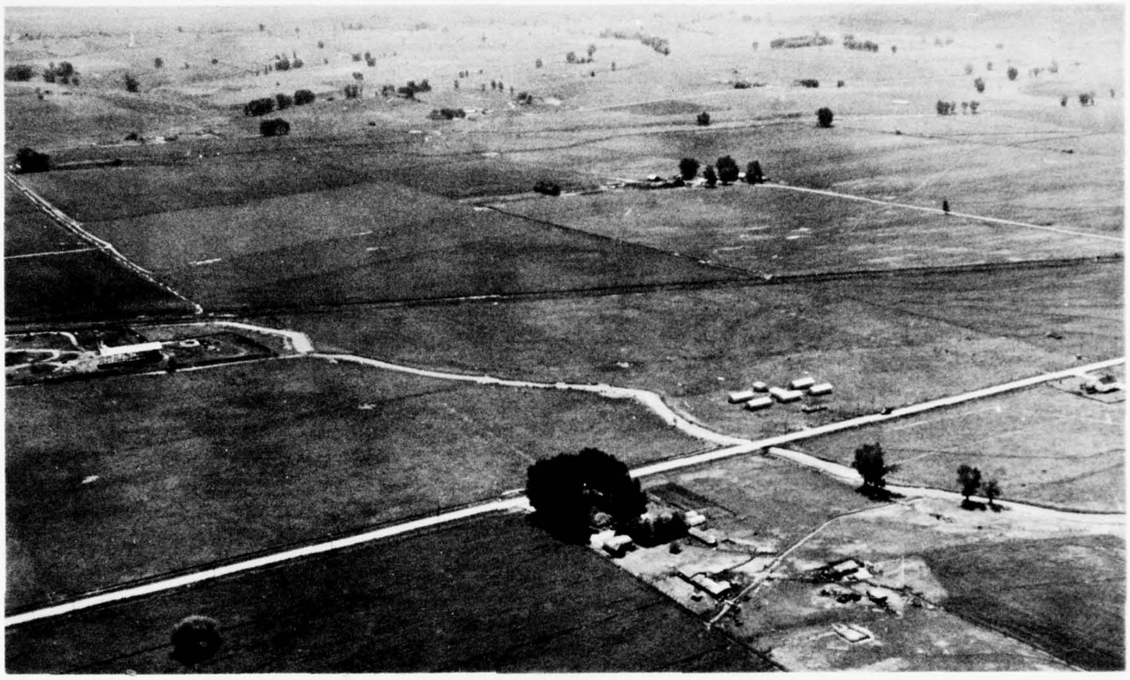
Copper mining and processing in Montana (U. S. Bureau of Mines).

Bitterroot Subarea (Subregion 1)

The Bitterroot Subarea, which consists of the Bitterroot River drainage is located in the extreme southwestern corner of Montana. Mountains occupy the east and west sides of the basin; the broad central valley is one of the principal irrigated areas in the subregion. The economy is based on agriculture and lumbering. There are historical settlement sites within the valley, and primitive natural areas in the Bitterroot Mountains.

Irrigation diversions deplete the low summer flows of the Bitterroot River curtailing the fishery between the towns of Woodside and Florence where a minimum flow of at least 150 cfs is desired. About 43,000 acres of the 119,000 acres of irrigated lands now experience water shortage, and there are 67,000 acres that are potentially irrigable. Minor flood damages occur all along the main stem of the Bitterroot River. The primary treatment plant at Hamilton becomes overloaded in the summer from cannery wastes.

Adequate storage capacity is available in Painted Rocks Lake on the West Fork for minimum fish flows, but existing water rights would have to be modified and irrigation diversions monitored to insure that these flows are maintained. Other alternatives include additional upstream storage, exchange of water rights, and a system of canals and pipelines to serve the valley. The alternative of excluding new irrigated lands was rejected because the



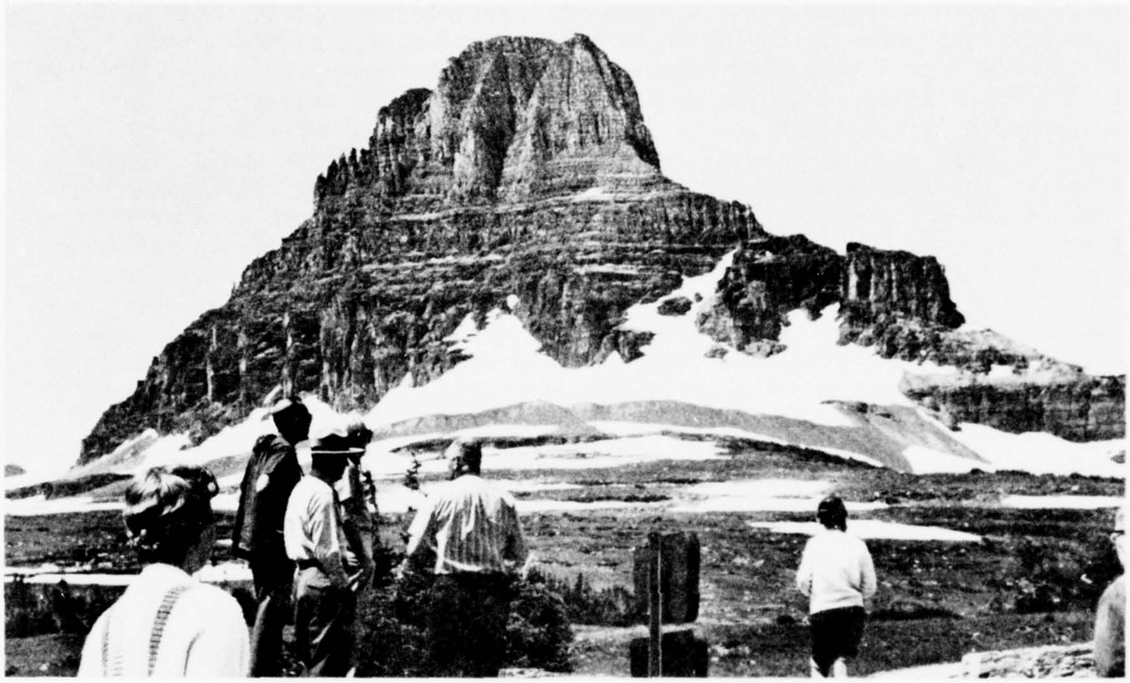
Bitterroot Valley in Montana–irrigated forage crops support livestock (USBR).

basin is oriented towards agricultural development, sufficient lands and water supplies are available, and the food and fiber needs could not be met more economically elsewhere in western Montana.

Selected general solutions include enlargement of two existing reservoirs and use of unused space in another to provide an additional 33,000 acre-feet of storage for irrigation, flood control, and flow augmentation for fisheries downstream from Woodside. The additional flow in summer low-flow periods would also improve water quality. This storage also would permit irrigation of 21,000 acres of new land and furnish a supplemental supply for 43,000 acres of existing water-short land. Also modernizing and combining the existing irrigation systems and water districts should be undertaken. Development on flood plains should be regulated. A scenic road should be designated on the west side of the Bitterroot River and its east fork, and a study made on designation of the Bitterroot below the forks as a recreational river. Land treatment measures would be carried out on 11 watersheds.

Flathead Subarea (Subregion 1)

The Flathead River and its tributaries, which originate on the western slope of the Continental Divide, drain an area of scenic mountains and valleys. The North Fork and portions of the Middle and South Forks of the Flathead



Glacier is but one of seven national parks within the region (Montana Highway Commission).

River are under study as potential wild and scenic rivers of national significance. The wilderness areas, Glacier National Park, Flathead Lake, and the rugged timbered mountains surrounding the entire basin provide environmental values unparalleled in the Nation. The economy centers largely around lumbering and agriculture, with recreation occupying a strong third place.

Major flooding occurs along the Flathead River between Columbia Falls and Flathead Lake. About 277,000 of the 458,000 acres of potentially irrigable land should be developed and supplemental water furnished to 127,000 acres of existing irrigated lands to meet projected needs. Constrictions at the outlet of Flathead Lake could be removed to reduce flood damage along the lakeshore and permit full use of the lake storage for regional power and flood control.

Discharge of municipal wastes into the slow-moving Ashley Creek at Kalispell is creating a serious pollution problem. Water quality problems are growing at Flathead and other lakes that receive wastes from recreation activities, homes and other sources. The basin is popular for recreation and fishing opportunities; however, there is a lack of picnicking and camping facilities, hiking trails, and swimming access areas.

Alternatives range from full structural development for power, irrigation, flood control, and watershed protection, to nondevelopment with the preservation of streams and lakes in their present state, and the control of

water pollution. Under full development, hydroelectric power could be developed at Smokey Range site on the North Fork (330 megawatts), at the Spruce Park site on the Middle Fork (380 megawatts), and at two run-of-river plants downstream from Flathead Lake, Buffalo Rapids 2 and 4 (552 megawatts). The Confederated Salish and Kootenai Indian Tribes, in conjunction with the Montana Power Company, have applied to the Federal Power Commission for a license to construct the latter two projects. Irrigation development could be met by direct diversion from the Flathead River and tributary streams, from existing storage at Hungry Horse Reservoir and Flathead Lake, and from storage at various potential sites. Flood protection for Kalispell and vicinity could be met from new upstream storage, levees, and channelization at specific locations between the South Fork and Flathead Lake. Water quality would be improved by control of wastes. There are adequate land and water resources in the basin to satisfy recreation, municipal and industrial water supply requirements, as well as fish and wildlife habitat development.

Because both the problems and their solutions are complex, additional interdisciplinary studies beyond the scope of this investigation are required to formulate the best plan for the basin. After analysis of the alternatives, solutions were selected for purposes of this framework study on the basis that the plan would be modified by further studies.

A levee to protect the Kalispell area and regulation of development on the flood plains are essential for flood damage reduction. The outlets of Flathead and Swan Lakes would be improved for flood control, and to stabilize lake levels for recreation and increased power production. The improvements to the outlets would be dependent on providing operating plans to avoid adverse environmental impacts and to meet the needs of lakeshore residents for recreational and other uses. Flood plains in Flathead and Lake Counties would be studied and managed to regulate development. Forest land would be treated. Supplemental water supplies for 127,000 acres of water-short land and new water supplies for about 277,000 acres of new land would be supplied by diversions from Flathead River and Lake. A secondary treatment plant would be constructed at Kalispell, and the effluent carried directly to the Flathead River, bypassing Ashley Creek.

Additional camping and picnicking sites would be established on Flathead and Whitefish Lakes and a scenic road designated around Flathead Lake and up the North Fork of the Flathead River. On the basis of additional studies, a decision would be made on whether the North Fork and portions of the South and Middle Forks of the Flathead River should be included in a national system of wild and scenic rivers. A study would be made of ecology of lakes and streams in the Flathead River Basin, and a plan developed to retain and improve water quality, fish and wildlife, and esthetic values. The designation of the upper Swan as a recreational river and the conversion of part of the west portion of Glacier National Park into a national wilderness would be investigated. Land treatment or measures would be implemented on 17 watersheds. The existing inadequate fish passage at the dam below Swan Lake would be rehabilitated. Land

for waterfowl management would be acquired or leased north and south of Flathead Lake and near Smith Lake on Ashley Creek. Inclusion of the two run-of-river hydroelectric plants on the Flathead River at Buffalo Rapids 2 and 4 is dependent on favorable action by the Federal Power Commission and applicants.

Lower Clark Fork Subarea (Subregion 1)

In this portion of the region which extends from the mouth of the Blackfoot River downstream to Lake Pend Oreille, the Clark Fork River flows through the rugged Bitterroot, Coeur d'Alene, and Cabinet Mountains. Lumbering is the major industry, with some mining; agriculture is limited to the narrow valleys.

Flooding occurs along several reaches of the Clark Fork River between Missoula and Plains, and on the St. Regis River. High water damage along the Clark Fork could be reduced by major storage in the upper basin at Ninemile Prairie, by local levees and channelization, or by flood plain zoning. Because of conflicts, Ninemile Prairie storage was not included in the plan; no practicable flood control storage sites are available on the St. Regis River. Consequently, the general solution would include regulation of development on the flood plains, extensions of the levee system at Missoula, and construction of levees at several places on the St. Regis River.

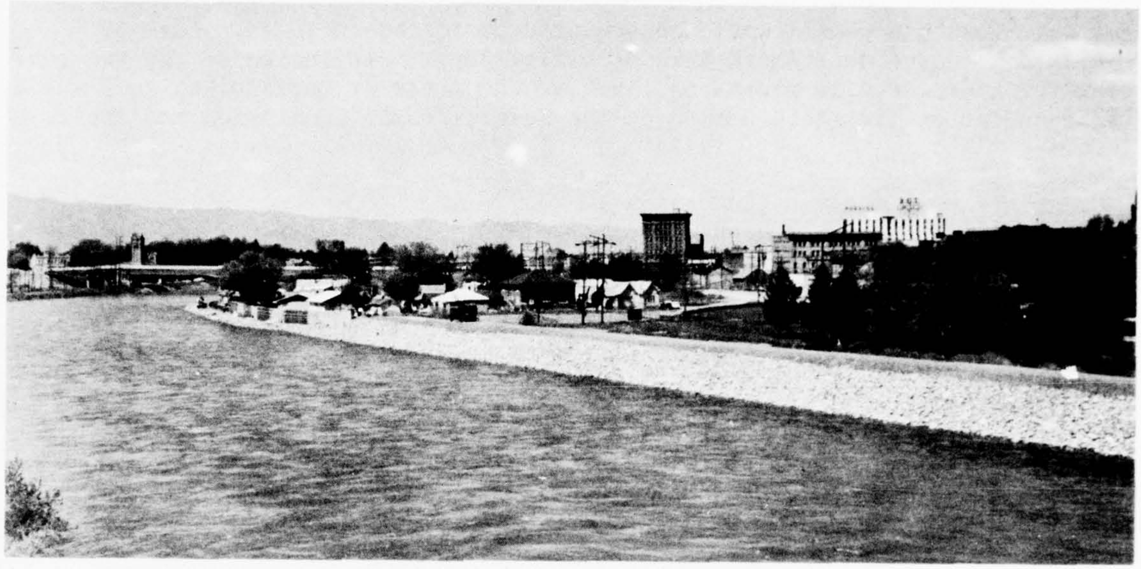
The lower Clark Fork Subarea has 35,000 acres of land under irrigation, of which 4,000 acres are water-short; an additional 171,000 acres are potentially irrigable. Water supplies for 95,000 acres of new land would be obtained by pumping from the Clark Fork River. Lands now experiencing a shortage would be furnished a supplemental supply from ground water.

The quality of surface water is reduced by discharges of inadequately treated sewage from small communities, and by wastes from a large pulp and paper plant at Missoula. The plan includes installation of waste treatment facilities to improve water quality to State standards.

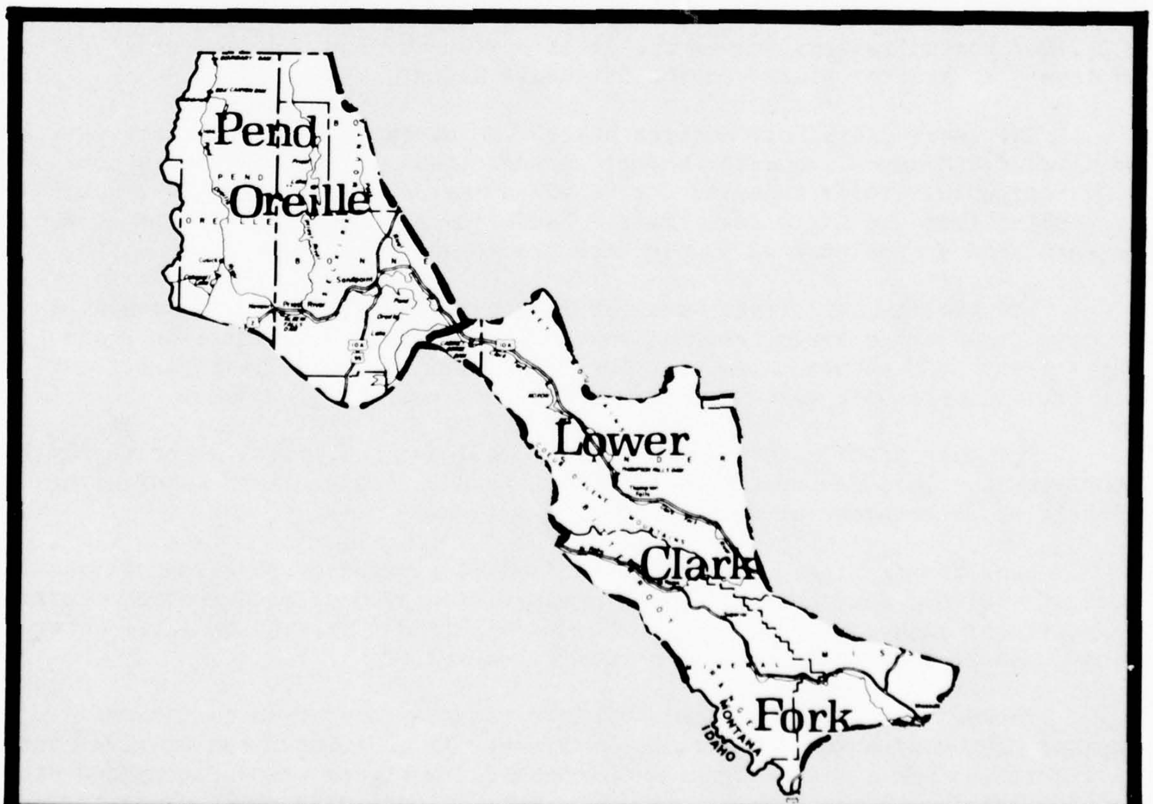
The only major requirement for municipal and industrial water supply is at Missoula. This demand can be satisfied by additional ground-water withdrawals or development of nearby tributary streams.

Land treatment and measures needed on 10 watersheds for flood protection, erosion control, drainage, and water conservation are included in the program. In addition, emphasis would be given to forest land treatment on three watersheds, and problems near Mud Lake would be corrected.

There are three hydroplants in this subarea, one of which (Noxon Rapids) can be expanded for peaking purposes. An additional run-of-river site is available, but its practicability depends on upstream storage. Pumped storage developments would also be possible, but regional peak power needs can be



Flood control levee at Missoula, Montana (USCE).



met more economically elsewhere. Consequently, only the expansion at Noxon Rapids to increase its peaking capability by 71 megawatts was included in the plan.

The subarea has high environmental and recreation values, excellent sports fishing, and key winter big game ranges. There are no significant problems or special measures needed except for a study of the Bull and Thompson Rivers which have potential for designation as wild rivers.

Pend Oreille Subarea (Subregion 1)

This land area is comprised of the Pend Oreille Lake and River drainage down to the Canadian border. Agriculture, mining, and recreation are the key economic elements.

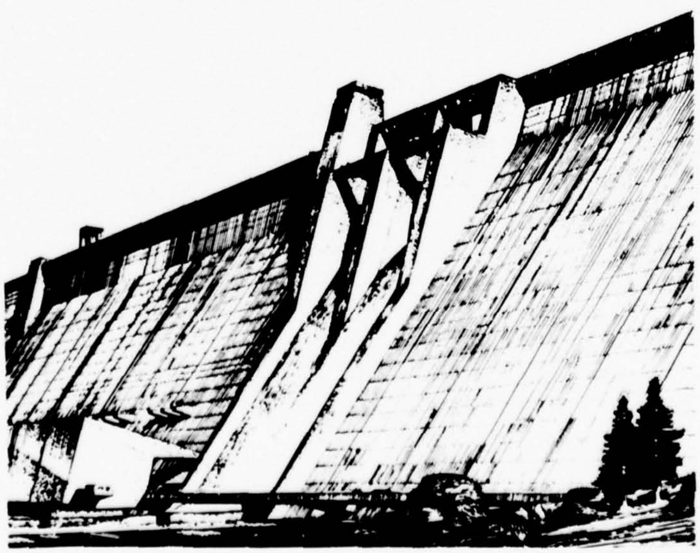
Flood damages occur along the shoreline of Pend Oreille Lake, the Pend Oreille River, and Calispell Creek. Upstream storage provides some protection; and Albeni Falls Dam, downstream from Pend Oreille Lake, assists in stabilizing lake levels. However, full control of flooding would require levees or additional upstream storage. Land treatment, erosion control, drainage, and tributary flood protection are required at a number of locations. Although only 8,000 acres are irrigated at the present time, there are 367,000 acres of potentially irrigable land, 49,000 acres of which could be served by pumping from the Pend Oreille River or its tributaries. There is considerable pleasure boating on the lake and river, and transfer facilities for small boats past Albeni Falls Dam has been requested by local interests. The city of Sandpoint discharges sewage with only primary treatment into Pend Oreille Lake.

The Priest River from Canada to its confluence with the Pend Oreille River is under study to determine whether this stream should be included in the national system of wild and scenic rivers. Protection of the excellent sport fishery in the lakes and streams and of key big game winter ranges are required. There are three major hydroelectric plants on the Pend Oreille River, one of which, the Boundary Project, can be expanded 50 percent over its present installed capacity of 551 megawatts. There are also several pumped storage power sites available, but regional peak power needs can be met more economically elsewhere. The large, clear expanse of Pend Oreille and Priest Lakes in the setting of forested mountains is an environmental asset of great importance.

Natural resources are more than adequate to meet future demands. One alternative would be essentially nondevelopment, with the exclusion of hydroelectric expansion and irrigation from the plan. This alternative was eliminated because the river is already committed to hydroelectric operation, and the irrigation of the farmlands is required to meet food and fiber needs.

Regulation of development on flood plains, construction of a supplemental pumping plant on Calispell Creek, and levees along Pend Oreille River would

Potentially irrigable lands north of Pend Oreille Lake (USBR).



Rendering of the Libby project on the Kootenai River in Montana; project is scheduled to have installed capacity of 420 megawatts by 1974 (USCE).

meet flood control needs. About 16,000 acres of land would be irrigated by diversions from the Pend Oreille River and tributaries. Mining wastes at Metalline Falls would continue to be ponded. The wild river study of the Priest River would be completed, and a decision made as to its inclusion in the national wild and scenic rivers system. A study would be made on designating the Pend Oreille River below Pend Oreille Lake as a recreational river. Seventeen watersheds would be studied to determine where cooperative practices and structures would assist in meeting needs for soil and water conservation and water supply. Forest land treatment would be carried out at three locations.

A scenic road system would be designated along the river below Newport, with branches near Newport and Metalline Falls. Lands would be acquired or leased for protection and management of upland game birds. Power facilities at the Boundary Project would be expanded.

Kootenai Subarea (Subregion 1)

The Kootenai drainage consists of that portion of the Kootenai River Basin located in the United States. The landscape is characterized by mountain ranges, some developed valleys, and scenic streams. The economy is based largely on lumbering and wheat farming, with some mining.

Flooding will be controlled along the main stem of the Kootenai River upon completion of Libby Dam. However, the downstream levees must be maintained to a height commensurate with the discharge from the reservoir. There are many areas requiring measures for land treatment, tributary flood prevention, erosion control, and drainage. There are about 236,000 acres of potentially irrigable dry land in the subarea; only 9,000 acres are currently irrigated. Flows in the Kootenai River are adequate for municipal and industrial water needs. The waters of Koocanusa Lake created by Libby Dam may be seriously affected by wastes from gypsum fertilizer production and coal strip mining operations in Canada. The wastes are being monitored, and studies of the water quality problems are underway between the two countries; corrective measures should be taken.

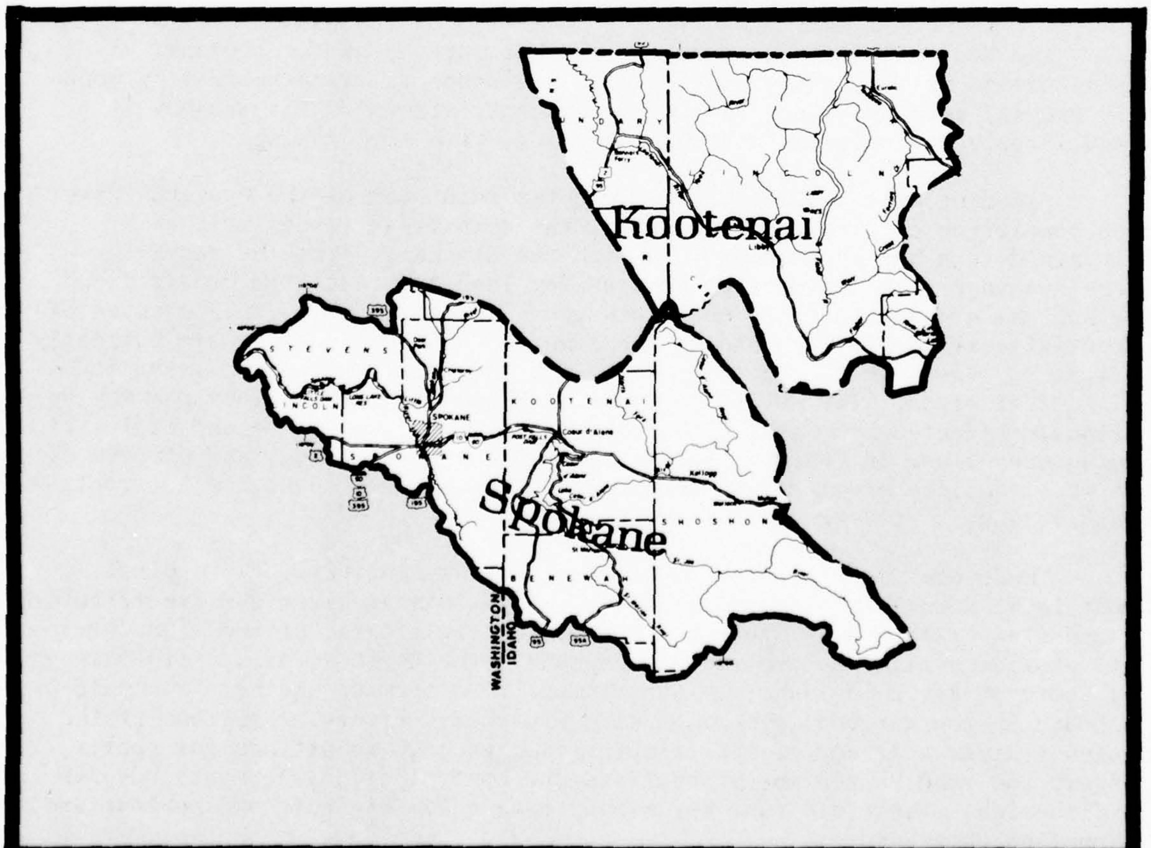
There are significant environmental values, including the Cabinet Mountain Wilderness and those relating to the Kootenai River and its tributaries as affected by the Libby Project. The recreation program at the Libby Project will provide a major recreation development. The Moyie River, a tributary of the Kootenai River in Idaho, is under study to determine whether it should be included in the national system of wild and scenic rivers. Portions of the Kootenai River and some of its tributaries have high importance for sports fishery and require minimum streamflows and control of developments adverse to fisheries. There are many key winter ranges for big game and habitat areas for upland game birds.

The Libby Project is scheduled to have an installed capacity of 420 megawatts by 1976. The capacity is planned to be doubled after 1980, and a reregulating dam constructed with installed capacity of about 50 megawatts. Under the terms of the 1961 Columbia River Treaty, after 1984 Canada may divert part of the Kootenai River flow into the Columbia before it enters the U.S. This possibility is a major consideration in planning the use of the water resources in the basin.

Regulation of the flood plains in Lincoln County, Montana, and Boundary County, Idaho, is required to control developments. The flood control program assumes that levees in the Kootenai Flats area will be maintained to heights commensurate with the anticipated discharges from the Libby Project.

About 85,000 acres would be irrigated with half located along the Kootenai River and the remaining in the Tobacco and Fisher River Valleys.

Studies would be made of 12 watersheds to provide, by cooperative



effort, implementation of practices and structures that would help meet the needs for water and soil conservation and water supply.

Suspended and settleable solids are being removed from the vermiculite mining and processing operation now discharging into the Rainy River, a tributary of the Kootenai. Waste treatment would be provided at municipalities, and septic tank installations would be controlled to meet quality standards. Studies of the water quality problems created by phosphate nutrients from gypsum fertilizer production, and strip coal mining wastes in Canada, are underway between the two countries and would be completed.

On the basis of the ongoing wild rivers study, a decision will be made on whether the Moyie River will be classified under either a state or national system of wild and scenic rivers. Streams tributary to Libby Reservoir which have valuable spawning areas would be preserved and improved for propagation or harvest of fish. Future diversions will be limited so that the minimum flows for fish production are maintained.

Areas near Eureka should be acquired for sharp-tailed grouse refuge. Additional wetlands also would be obtained for waterfowl along the Kootenai River downstream from Bonners Ferry.

Spokane Subarea (Subregion 1)

This area of consideration includes the Spokane River drainage, which originates in Coeur d'Alene Lake, and the St. Joe and Coeur d'Alene Rivers, which are tributary to the lake. The Bitterroot Range on the Idaho-Montana border forms the eastern boundary of the subarea. The economy is based on irrigated agriculture and industry in the Spokane Valley, wood products and recreation around Coeur d'Alene Lake, and mining in the Kellogg, Wallace, and Mullan areas.

Flood damages occur along the Coeur d'Alene River and its tributaries, around Coeur d'Alene Lake, in the valley of the St. Joe River, along Hangman Creek and Little Spokane River, and to a minor extent along the Spokane River. Existing waste settling ponds on the South Fork Coeur d'Alene River need protection to prevent damage during floods. Channel improvement for flood control has been authorized along Placer Creek through the town of Wallace.

There are many areas requiring watershed treatment, including drainage and erosion control. About 44,000 acres of land were irrigated in 1970, and there are 915,000 acres of potentially irrigable land remaining. About 50,000 acres of dry land could be irrigated from ground water; an additional 140,000 acres would require surface water supply to meet needs. Surface water could be supplied by pumping from either the Spokane or Pend Oreille Rivers during spring runoff.

Towing of logs from points along the St. Joe River to mills at the north end of Coeur d'Alene Lake is hampered by conditions of the channel of the St. Joe River near its mouth.

Principal municipal and industrial water supply needs are in the Spokane service area, at the city of Coeur d'Alene, and in the vicinity of Kellogg, Idaho. These needs can be satisfied from surface and ground-water sources. Municipal waste disposal on the South Fork of the Coeur d'Alene River causes a serious water pollution problem, as does drainage from mining tailings which continually release toxins. Application of secondary treatment to Spokane's municipal and industrial waste, although reducing both the oxygen deficiency and algae growth downstream, would still produce an effluent which cannot be diluted adequately by the low summer flow in the Spokane River. There is a possibility also of contamination of ground water in the Spokane area from septic tank discharges. Augmentation of the streamflows of the Spokane River is needed for water quality and fisheries.

Environmental considerations are of great importance in the basin. The St. Joe River is under study to determine whether it should be included as part of the national wild and scenic rivers system. There are needs for additional facilities for camping, picnicking, and boating; for access to additional recreation, fishing, and hunting areas; and preservation of streams and historical areas. Streams tributary to Coeur d'Alene Lake are valued for spawning and should be protected or reclaimed. Establishment of minimum flows for fisheries and the acquisition of wildlife habitat are requirements.

There are seven small hydroelectric plants on the Spokane River. A number of potential hydroelectric sites remain on the Coeur d'Alene River. The Spokane and Coeur d'Alene Indian Reservations have water rights which require consideration in planning.

There are a number of alternate plans, some of which conflict with environmental quality. Upstream reservoirs on the Coeur d'Alene River could store up to 250,000 acre-feet to augment low water flows, to aid in flood control, and provide water for irrigation, water quality, power, recreation, and fisheries. However, the reservoirs would inundate areas of high environmental value. In addition, this alternative would require legislation in Idaho to allow storage of water for irrigation use in Washington. Another alternative, which would provide offstream storage for irrigation with high-lift pumping from the Spokane River, would further reduce the low flow of the river with adverse effects on water quality, the resident fishery, and power. Low-lift diversion from the Pend Oreille River into offstream storage could satisfy irrigation and provide some return flows into the Spokane River to augment streamflows. Limiting irrigation to presently available water would not solve the water quality problems during summer low flows in the Spokane River. Nondevelopment would not solve any of the current problems.

The problems in the Spokane Basin require detailed investigations

The Enaville damsite on the Coeur d'Alene River (USCE).

beyond the scope of this study to determine the best plan. For the purpose of this framework study, the following plan was utilized on the basis that it could be modified as the result of further study.

Development on flood plains should be regulated, and levees on Pine Creek at Pinehurst and at the town of Pine Creek should be constructed. The channel on Placer Creek through Wallace should be rebuilt. About 190,000 acres of land would be irrigated; of this amount, 33,000 acres could be supplied by ground water. Storage should be studied on the Coeur d'Alene River to augment low flows in the Coeur d'Alene and Spokane Rivers to improve water quality, reduce flood damages, stabilize lake levels, and provide water for irrigation and power. Forty watersheds would be studied to determine the necessary management practices and structures required to meet the needs for water and soil conservation and water supply.

Waste disposal into the Coeur d'Alene and Spokane Rivers and their tributaries would be controlled to meet State standards. A total waste-water management study would be made to determine sources of nutrients and pollutants entering Coeur d'Alene, Hayden, Spirit, and Twin Lakes, and necessary corrective action to be taken. Mine waste settling ponds on the South Fork Coeur d'Alene River would be made more effective in removing toxins and protected against inundation by floodwaters.

Streams tributary to Coeur d'Alene Lake should be preserved and

protected as spawning habitat areas. Scenic roads should be designated on the Spokane and Little Spokane Rivers and to the west and southwest of Spokane. A study should be made on designating the Spokane as a recreational river. Minimum flows for fish and other purposes should be established. Wetlands in the lower Coeur d'Alene Valley near Rose Lake should be acquired or leased for waterfowl management. The wild and scenic river study on the St. Joe River will be completed and a decision made on what sections qualify for inclusion in the national wild and scenic rivers system. Further consideration of the improvement of the mouth of the St. Joe River for navigation will depend on the results of this study.

Main Stem of the Upper Columbia River (Subregion 2)

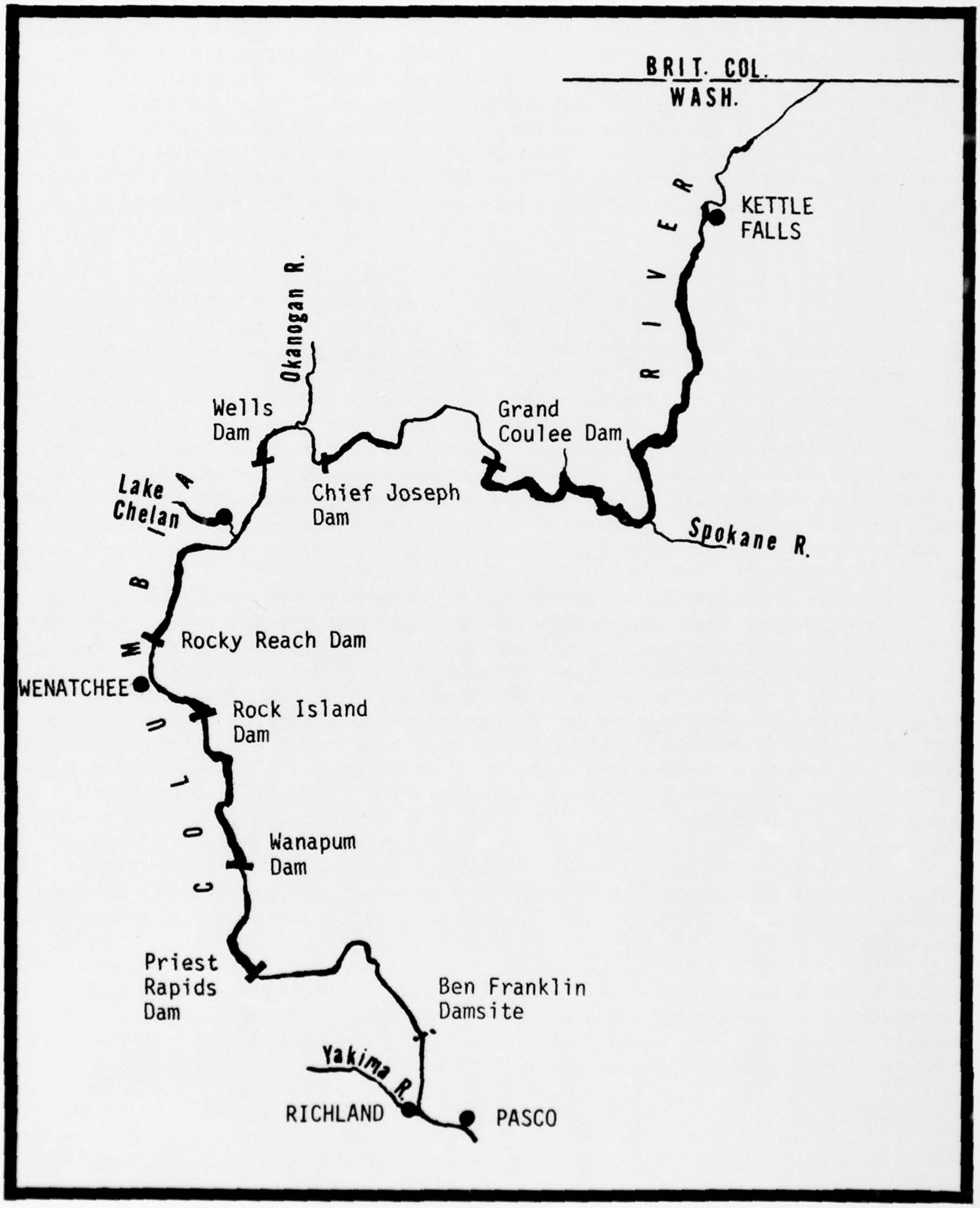
The main stem of the Columbia River from the Canadian border to the mouth of the Snake River contains a series of seven dams and reservoirs leaving 57 miles of open river below Priest Rapids Dam. With completion of the Columbia River Treaty projects a substantial amount of storage will be added to the system for regulating the seasonal fluctuation. As electric power generation shifts to a thermal base, the hydroelectric projects would be operated more and more for peaking and planned additional hydrogeneration would be for peaking purposes.

The shorelands, particularly in the Hanford area, are suitable for thermal electric installations to serve the densely populated coastal area in the Willamette-Puget Sound trough. They also have a potential use for industry, residences, recreation, and wildlife. Navigation upstream from the lower river is not possible at this time because of shallow bars in open river stretches and barriers formed by dams. However, the dams below Chief Joseph Dam have provisions for construction of future locks when justified.

The river has geologic, historic, and unique areas and high environmental values, including fish and wildlife, recreation, and esthetics, that should be preserved. Pleasure boating use, both from local residents and boaters living out of the area, is increasing. Additional moorages and related boating facilities are needed.

There is need for reducing levels of nitrogen supersaturation which occur below storage projects during periods of high spring runoffs when the use of spillways is required. Water quality control is needed to insure that Federal-State standards are met. The desires and water rights of the Colville Indians must be included in any long-range planning.

Three alternatives viewed for the subarea range from severely restricting future development to significant additional installation of structures. For all alternative schemes, the authorized and planned additional generating facilities would be added to the existing upstream dams.


BRIT. COL.
WASH.
KETTLE FALLS
RIVER
Okanogan R.
Wells Dam
Grand Coulee Dam
Chief Joseph Dam
Lake Chelan
Spokane R.
COLUMBIA
Rocky Reach Dam
WENATCHEE
Rock Island Dam
Wanapum Dam
Priest Rapids Dam
Ben Franklin Damsite
Yakima R.
RICHLAND
PASCO

One alternative, and the most restrictive, would be to classify the segment of the Columbia River from Priest Rapids Dam to Lake Wallula (McNary pool) as a scenic or recreation river. This reach is currently designated for such study under section 5(d) of *Public Law 90-542. If this alternative* were selected, the river would remain in its present state; and flow fluctuations, due to power peaking operation, would be controlled to harmonize with wildlife and recreational use. This alternative would have the minimum environmental impact, but navigation would not be provided and substitute facilities for electric power would be required to provide the capability foregone.

Another alternative would provide for dredging of a channel for the 57-mile stretch of river below Priest Rapids Dam and construction of locks at upstream dams to provide shallow-draft navigation to Wenatchee. Recent studies have shown that by 1980 shallow-draft navigation would allow movement of more than 4 million tons of commodities at less cost than land transportation. However, both the disposal of dredging material and the timing of construction could affect the spawning of anadromous fish in the river and have some effect on sports fishery. Peaking operation of the upstream dams would not affect navigation. This alternative could be further modified to include such adjustments as can be made in minimum releases at Priest Rapids Dam to reduce the extent of channel dredging, thus minimizing environmental impacts.

A third alternative would include Ben Franklin Dam, some dredging at the head of McNary pool, and navigation locks at the three upstream dams to allow shallow-draft navigation to Wenatchee. Ben Franklin Dam would be a multiple-purpose development about 49 miles below Priest Rapids Dam. It would have an installed capacity of 938 megawatts and generate an average of 428 megawatts, and would serve to damp out flow fluctuations caused by peaking operations of upstream dams to and including Grand Coulee. The alternative would benefit recreational and commercial navigation and permit maximum peaking power with minimum river fluctuations but would have the maximum environmental impact.

Before any of these alternatives can be selected, detailed interdisciplinary studies would be required to establish the effects of peaking operations, channel dredging, and additional power development on the area's environment.

For the purpose of this framework study, the alternative providing for extension of barge navigation to Wenatchee with a dredged channel and locks in three existing dams in the period 1980 to 2000 was used on the basis that the plan would be altered to conform to the results of further studies. This alternative appeared to provide significant economic advantages to Central Washington with the least adverse environmental impacts.

Electric power elements common to all alternatives would include the

installation of additional units at Grand Coulee, Wanapum, Rock Island, and Chief Joseph Dams, raising their combined installed capacity by 7,494 megawatts. Also, thermal generating plants with a total of 10,200 megawatts capacity using cooling towers or ponds would be constructed.

Fish and wildlife habitat would be preserved by leasing or acquisition of lands. Where feasible, hydroelectric plants should be modified and operated to reduce nitrogen concentrations. Additional recreational facilities would be constructed and a plan for a scenic parkway along the river would be prepared and implemented.

Big Bend Subarea (Subregion 2)

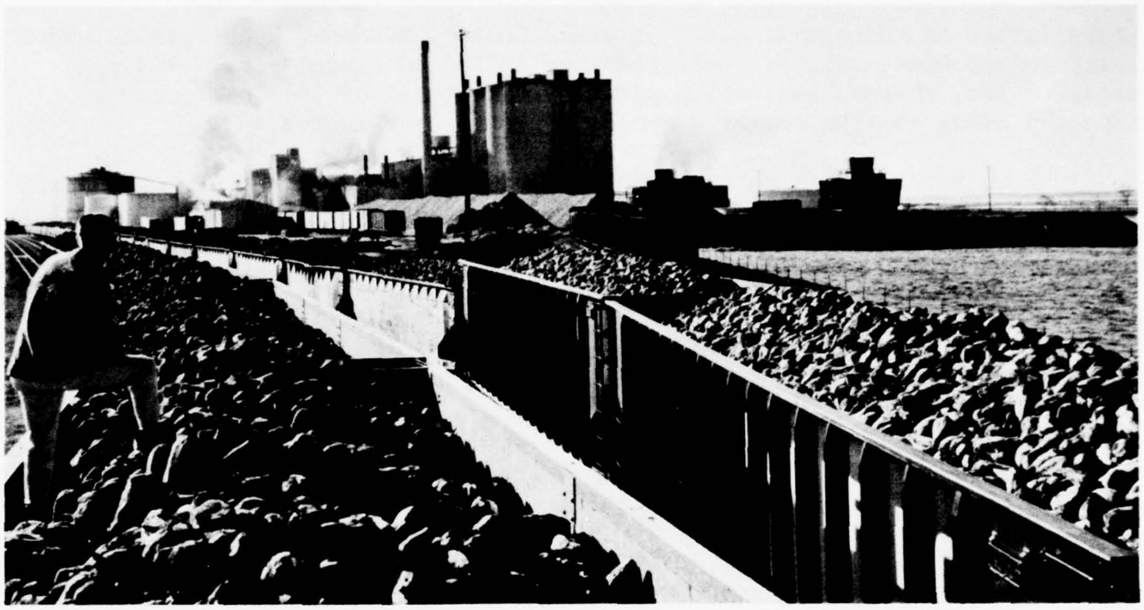
The Big Bend Subarea, which lies south and east of the Columbia River in Central Washington, is a relatively high and flat plateau cut by deep coulees; Crab Creek is the only significant perennial stream.

The Crab Creek Basin experiences recurring flood damages, particularly at the towns of Odessa, Wilson Creek, and Ephrata. Also, damages occur to 1,500 acres of agricultural land in Moses Coulee where floods occasionally deposit silt and sand over a portion of Palisades Irrigation District. Floods in Esquatzel Coulee cause damages to the town of Mesa. Upstream storage, channelization, and levees are alternatives which could reduce flooding. Flood plain regulation would be effective in reducing the growth of future damages.

About 702,000 acres of farmland are irrigated. The largest block of irrigated land is in the Columbia Basin Project, where an additional 561,000 acres remain to be developed. The water supply for this ultimate 1.1 million acre project has been provided through construction of Grand Coulee Dam and Banks Lake. In addition to the Columbia Basin Project, there are 1,260,000 acres of potentially irrigable lands. Water supplies for 482,000 acres located adjacent to the project could be obtained by pumping from either Banks Lake or Roosevelt Lake. Offstream storage might be desirable for much of the other potentially irrigable lands which are farther from these water sources. Ground waters in some areas are overappropriated, and the state has taken steps to curtail their use for irrigation.

At some locations ground water has excessive nitrate-nitrogen concentrated. Seasonal low flows in some reaches of Crab Creek are inadequate to dilute agricultural return flows and wastes from feedlots. Water quality is not satisfactory in many reaches of the stream.

Below O'Sullivan Dam, Crab Creek has potential for development of anadromous fish spawning grounds. However, streamflow increases are necessary to overcome restrictions on current fish production, as well as to enable implementation of enhancement measures. The Columbia Basin Project has



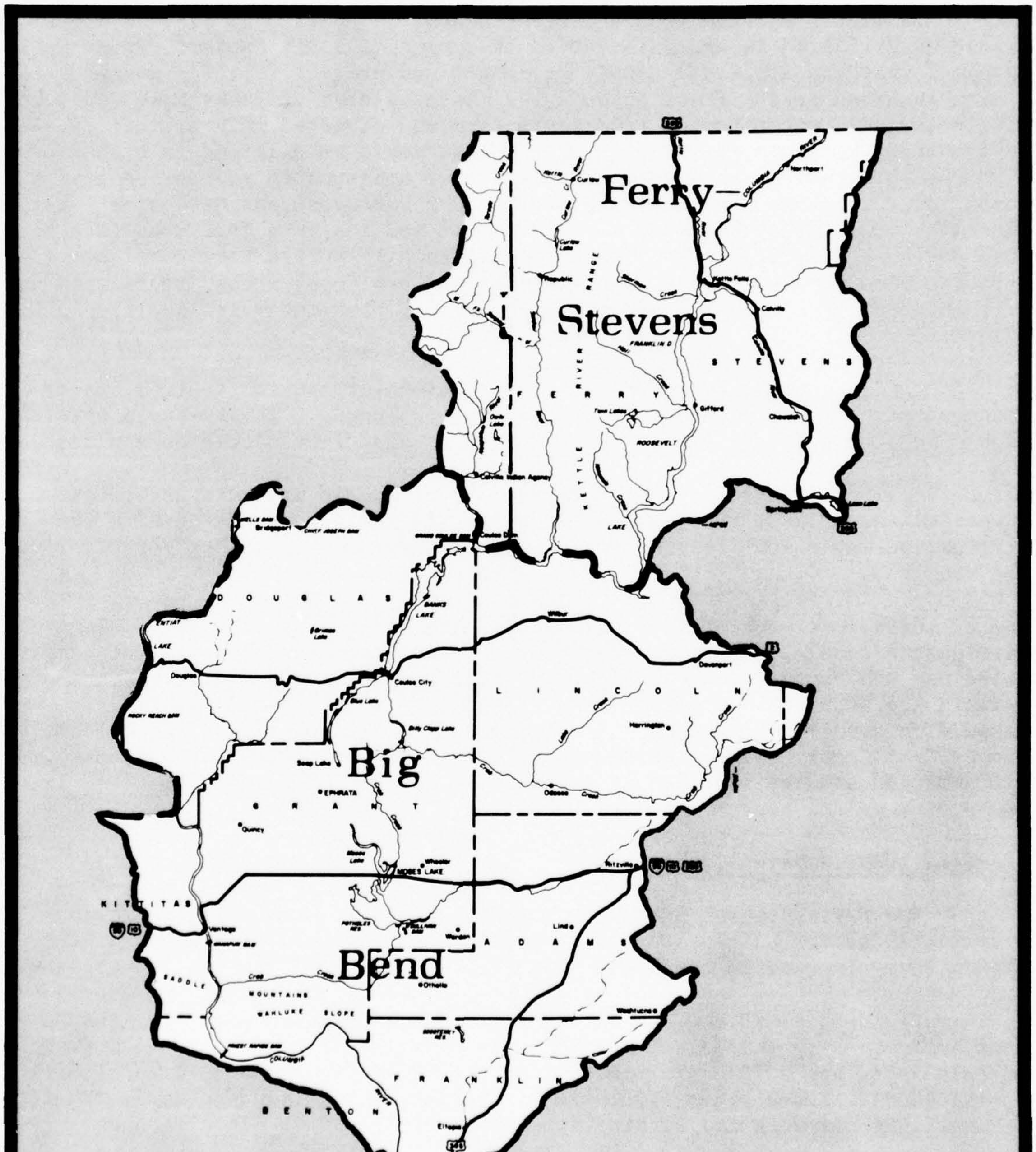
Sugar beets raised on irrigated lands in the subarea are transported to a refinery for processing. Rail and freight facilities transport these products to markets throughout the West (USBR).

provided resting, nesting, and feeding habitat for large populations of waterfowl and upland game birds. Leasing or acquisition of additional areas along future canals, wasteways, laterals, and other irrigation associated wetland areas would enable an increase in bird populations and hunting opportunities. Development of access sites along publicly held rights-of-way would help provide free hunting access. The current resident fish management program is adequately meeting present demands for lake and reservoir fishing and is expected to continue.

The area has unique geologic formations of scenic value and considerable opportunities for increased recreation activity, particularly at Potholes Reservoir and at several seep lakes.

Accelerated watershed development is required at several locations. Although there are no apparent conflicts among projected resource uses in the area, the complexity and magnitude of solutions considered warrant detailed interdisciplinary studies. Accordingly, the following framework plan could be altered by the findings of future studies.

Flood control measures include channel improvement on Crab Creek at Odessa and on Dry Creek at Ephrata, and regulation of development on flood plains. Land measures required to reduce damages on lands in Moses Coulee would be accomplished. The town of Mesa in Esquatzel Coulee would be protected against floods up to 100-year level of recurrence with levees.



Ferry
Stevens
Big
Bend
FERRY
STEVENS
DOUGLAS
LINCOLN
GRANT
ADAMS
FRANKLIN
BENTON
KITTITAS
ROOSEVELT
Davenport
Coulee City
Soap Lake
EPHRATA
Quincy
MOSES LAKE
Ritzville
Othello
Washtucna
RICHLAND
PASCO

To meet projected food and fiber needs, an additional 578,000 acres would be irrigated in and adjacent to the Columbia Basin Project, an authorized project that has its water supply developed and project features constructed. Forty thousand acres of new land on the plateaus east of Banks Lake would be irrigated with water pumped from Banks Lake and diverted into project canals. Sylvan Lake upstream from the town of Odessa would be enlarged in excess of 100,000 acre-feet or an alternative reservoir constructed to provide irrigation water supplies for 182,000 acres between Davenport and Washtucna. Water supplies would be pumped from Roosevelt Lake and conveyed to Sylvan Lake for use during the irrigation season. Construction of Sylvan Lake Reservoir would provide flood protection to Odessa and other Crab Creek areas, recreation and fishing opportunities, and additional flows for fish and water quality in Crab Creek.

Land treatment measures would be applied for erosion control, water management, tributary flood control, and water supply. Thirty-seven watersheds would be studied to determine those where the practices should be applied.

Several potential pumped-storage hydroelectric projects using Lake Roosevelt as a lower reservoir could be developed in conjunction with providing irrigation water supplies for the Davenport-Washtucna area, but further study is required.

Waterfowl habitat lands should be acquired and habitat areas along irrigation canals, laterals, and waterways obtained and developed for game bird use and hunter access. An upland bird game farm would be constructed within the subarea. Wet areas resulting from the Columbia Basin Project should be acquired or leased and developed for upland birds and waterfowl. Lower Crab Creek would be developed as a spawning channel for anadromous fish if detailed studies indicate its suitability.

Ferry-Stevens Subarea (Subregion 2)

The Ferry-Stevens Subarea is predominantly mountainous with farms located in narrow valleys, principally along the Colville and Sanpoil Rivers. The economy is related to forest products, agriculture, mining, and recreation.

Flooding along the Colville River damages agricultural land, roads, and bridges. The channel of the Colville River upstream for 48 miles from Kettle Falls has a flat gradient which contributes to flooding of agricultural lands. Flood plain regulation, upstream storage, and levees with minor channel improvements are alternatives which could reduce flood damages.

About 21,000 acres are presently irrigated, and some 376,000 potentially irrigable acres lie in small tracts throughout the subarea. Lands lying adjacent to the Columbia River can best be served by pumping from Roosevelt Lake and from several small streams. In the Colville River Valley, potentially

irrigable lands could be served from surface and ground water without new storage. Sources for municipal, industrial, and rural-domestic water supplies are adequate.

Lake and ground-water pollution around intensively developed recreational properties poses a serious problem; examples are Loon and Deer Lakes where lake water quality has been a problem for several years. Correction requires collection and treatment. Total coliform organisms have exceeded recommended limits in the lower Colville River, but this can be alleviated with additional treatment facilities and correction of inadequate septic tank installation. Low flow augmentation would also improve water quality. The Kettle River Basin also experiences erosion and water quality problems.

The Sanpoil River main stem and West Fork warrant consideration for possible inclusion into a state or national system of recreation rivers. Improved habitat areas for big game are needed as are increased opportunities for fishing and hunting.

An alternative including levees and channel work on the Colville River and irrigation was adopted after consideration of nondevelopment alternatives. The adopted framework plan would result in little change to existing environmental values while the other alternative lacked response to needs.

The Colville River area during flood of 1956 (USCE).

Flood control measures would include regulation of the flood plains and levees and channel work on the Colville River from Kettle Falls to Deer Creek. Diversions from ground water and from Roosevelt Lake would provide the necessary water supplies to irrigate an additional 23,000 acres of new lands. A cooperative study with Colville Indian Reservation should be made to determine whether preservation of the Sanpoil as a recreation river would be warranted. Land treatment measures would be applied to meet the needs for erosion control, water management, cropland drainage, flood control, and water supply. Ninete watersheds would be studied to determine the ones that could help impleme these practices.

Methow-Okanogan Subarea (Subregion 2)

The Methow and Okanogan River Basins lie in the northwest portion of the upper Columbia River Area. The Methow River drains the eastern slope of the Cascade Range. The Okanogan River and its main tributary, the Similkameen River, derive 71 percent of their runoff from Canada. About 500,000 acres of the Colville Indian Reservation within the subarea require consideration of resource development needs and water rights in planning for the basin.

The Methow River Basin will soon be connected to the upper Skagit Basin via the North Cross-State Highway, making it the eastern gateway to the North Cascades National Park. The ensuing developments, both recreational and service facilities, will require continued planning to avoid large losses of environmental values.

The developed bottom lands of the Methow River Basin which are subject to flooding comprise about 2,500 acres of towns and farms. High flows, which carry large debris loads, cause severe bank erosion and flood portions of the towns of Twisp and Winthrop. Flood plain regulation and levees are alternatives which could reduce these damages.

Frequent floods on the Okanogan River inundate highways and agricultural land, and damage rural homes and residential areas in Omak, Okanogan, and Oroville. Higher, less frequent floods damage residential and commercial areas at Oroville, Tonasket, Riverside, Omak, and Okanogan. At times, the Similkameen floods at a higher level than the Okanogan, creating a reversal of flow into Osoyoos Lake in Canada, damaging homes around the lake. Flood plain regulation, levees, and upstream storage would be effective in reducing flood damages in the Okanogan Basin.

This basin also experiences shortages of water during the growing season which curtail irrigation and create water quality problems in both Canada and the United States. The lower Okanogan River suffers from high temperatures, high bacteria levels, and low flows in late summer. Other water quality problems are minor and industrial waste treatment is excellent.

About 74,000 acres are presently irrigated and 150,000 acres are

potentially irrigable. Potential irrigable lands are generally in scattered small tracts with the majority on high benches bordering the rivers. Natural flows in the Okanogan River are inadequate for irrigation expansion without upstream storage, but some lands, including 10,000 acres on the Colville Indian Reservation, could be served by diversions and high pump lifts from the Columbia River.

Adequate water to meet future municipal and industrial needs can be developed by expanding existing facilities.

The recreation attractions are the alpine and large upland lakes, rugged country for hiking and packing, fishing, and the excellent big game hunting, but there are problems of restricted access. Some of the principal streams of the area warrant study for inclusion in a state or national recreation river system. The Okanogan River supports important steelhead and salmon (blueback, chinook, and coho) runs which should be preserved and possibly enhanced. Fish and game habitat preservation and improvement, removal of fish passage barriers, and artificial propagation are alternatives which would help meet future fishing and hunting needs.

Upstream storage of 600,000 acre-feet would be necessary to satisfy all water needs of the Okanogan Basin for irrigation, water supply, flood control, and low-flow augmentation. The most suitable site on the Similkameen River in Washington, just above its confluence with the Okanogan, could store up to 600,000 acre-feet, but would inundate agricultural lands in Canada; 350,000 acre-feet of storage, which would back water to the border would meet most needs. Storage at Palmer Lake, which would meet only a small part of the needs, would inundate some big game winter range, orchards, and meadow lands. There are adequate storage sites on tributaries of the Similkameen River in Canada which could meet both United States and Canadian needs. Canada will complete a 4-year study of the Okanogan River Basin in 1973.

An interdisciplinary study fully coordinated with the ongoing study in Canada is needed to determine the proper plan for handling water and related land resources. Such investigation is beyond the scope of this study. Accordingly, the following framework plan was used for the purpose of this study on the basis that it would be modified to reflect the findings of further detailed investigations.

Okanogan County would regulate development in the flood plains. Logs and other debris would be removed from the Methow River channel to reduce damage to bridges and bank erosion during high flows. Land use planning of the Methow River shorelands would place reasonable controls on development resulting from construction of the new cross-state highway. Levees would be constructed along Okanogan River at Oroville, Riverside, Omak, and Okanogan.

Irrigation would be developed on 36,000 acres along the Okanogan River. Approximately 10,000 acres would be supplied from 20,000 acre-feet of storage within the United States. The remaining 26,000 acres would be served by minor


Methow
Okanogan
Wenatchee
Entiat
Chelan

storage, natural flows, and ground water. No additional major storage is included in the Okanogan River Basin; therefore, little additional water would be available for water quality improvement, fish, irrigation, recreation, and other uses.

Mitigation of unavoidable fish and wildlife losses would be accomplished. Fish passage facilities would be provided at Enloe Dam on the Similkameen River. Waterfalls and barriers to fish passage would be laddered or removed in the Methow River. Installation of aerators to prevent winter kill, increasing levels, and installing fish barriers are potential management measures to enhance fishing success in some area lakes. Studies would be made of the Okanogan and Methow Rivers to determine their suitability for inclusion in a national or state system of recreation rivers.

Some elements of the above mentioned units, as well as part of the land treatment program, would be supplied through programs on 24 watersheds.

Wenatchee-Chelan-Entiat Subarea (Subregion 2)

The Wenatchee, Chelan, and Entiat Rivers drain into the Columbia River from the east slopes of the Cascade Mountains in central Washington. These waters are generally of high quality.

High flows of the Wenatchee River cause flooding of low-lying rural areas near Cashmere and Monitor. The city of Wenatchee is subject to damages from floods in Canyons 1 and 2 which flow through the city to the Columbia River. Significant damage has occurred about every 10 years. Debris is deposited in agricultural and urban areas, and city streets are flooded, overloading sewers. Congress recently authorized the construction of a flood channel to solve this problem.

In the Entiat River Valley, 2,500 acres of irrigated farms near the river mouth are subject to flooding. During floods, the very steep gradient of this stream causes severe erosion. Flood control storage and other flood prevention measures are needed.

Irrigated lands which are devoted largely to fruit orchards include 15,000 acres in the Chelan and 1,900 acres in Entiat River Basins. Although there are 9,100 acres of potentially irrigable land, no additional irrigation development is expected.

The water rights of the Chelan Public Domain Allotments must be considered in planning for the Chelan River Basin.

The primary water-related land use problem is bank erosion. In rangeland areas, protective measures are needed to retard runoff, reduce erosion, and improve infiltration to the ground-water aquifers.

The upper end of Lake Chelan in Washington (NPS).

There is a hydropower project at the outlet of Lake Chelan. Chelan County PUD No. 1 has filed an application with the Federal Power Commission (Wenatchee Project No. 2151) for four power dams on the Wenatchee River. This proposed development would conflict with a designation of this river under Section 5(d) of P.L. 90-542 for study as a possible scenic or recreation river. The decision on whether to construct these projects rests with the Federal Power Commission.

Chelan County PUD No. 1 is conducting a detailed study of a pumped storage project at Antilon Lake, about 6 miles north of Manson, Washington. Lake Chelan would serve as the lower reservoir and Antilon Lake, about 1-1/2 miles to the east and about 1,300 feet higher, would be enlarged. The proposed output would be 1 million KW; in addition to power, the project would furnish water supply, irrigation, and recreation. The present findings are favorable.

The following framework plan was selected after consideration of non-development alternatives. The elements in the plan would be expected to have little adverse environmental impact and would meet the projected needs.

The existing powerplant at the outlet of Lake Chelan would be expanded by 224 MW.

Developments of flood plains would be regulated by counties. Flood damages in Wenatchee from Canyons 1 and 2 would be alleviated by an authorized

channel project which would carry floodflows to the Columbia River. Twelve miles of setback levees on the Wenatchee River below Leavenworth would be constructed to protect agricultural and urban lands from flooding along the lower 24 miles of the river. Land treatment practices would be applied to meet requirements for erosion control water management and supply and cropland drainage. Eleven watersheds are programmed for further study to help implement these practices.

Additional waste treatment would be provided by municipalities and industries to meet Federal-State standards. A comprehensive basin sewage plan would be developed for this purpose.

Camping areas would be expanded in the Cascade area of the Wenatchee and Chelan drainages. Visitation from the populous Seattle area is high. Development of hiking and riding trails, historic interpretation, and nature walks would be accomplished within flood plains near urban areas through county, state, and local planning. Studies would be made of the Wenatchee, White, Chiwawa, Little Wenatchee, and Entiat Rivers to determine their suitability for inclusion in a state or national system of recreation rivers.

Development of fish passage facilities at Dryden Dam, Leavenworth Dam, Tumwater Dam, and the 30-foot falls at river mile 15 on the Wenatchee River would provide additional spawning and rearing areas for anadromous fish. Additional fish passage facilities would be provided at river mile 6 on the Little Wenatchee River; waterfalls and barriers to fish passage would be laddered or removed in the Chiwawa and Methow Rivers. Installation of aerators to prevent winter kill, increasing water levels, and installing fish barriers are potential management measures to enhance fishing success in some lakes. Additional wildlife areas would be established in the Chelan, Colockum, McThau, Cottonwood Creek, and Lime Belt areas primarily for big game. Maintenance of adequate big game populations to satisfy hunting needs would depend primarily on protection of key winter ranges from noncompatible uses.

Yakima Subarea (Subregion 3)

The Yakima River Basin in central Washington is a major agricultural area with growing chemical and food processing industries.

The Yakima River Basin's present and future prosperity is closely linked to the quantity and quality of its water supply. Irrigation diversions and return flows, municipal and industrial waste effluents, and farm animal wastes are major factors presently affecting quality of the Yakima River. High stream temperatures, excessive aquatic growths, high turbidity, sediment, and bacterial organisms are present in the lower reaches of the river and have curtailed some uses. Increased growth without adequate safeguards would cause further reduction in Yakima River water quality and quantity. Projections indicate that municipal water use will nearly triple, industrial

use will more than double, and rural-domestic use increase by 50 percent. The greatest municipal and industrial water need is expected in the Yakima service area.

The basin is subjected to recurring flood damages. Flood-susceptible areas include irrigated farmlands and portions of the cities of Yakima, Ellensburg, and Toppenish, and of several small towns. About 509,000 acres are presently irrigated and another 632,000 acres of potentially irrigable lands are available. Approximately 106,000 acres of presently irrigated lands receive an inadequate water supply. Cropland problems are mainly onfarm irrigation water management and excessive wetness. Protective measures on forest lands are needed to reduce erosion.

During the past decade, the State has augmented the anadromous fishery by stocking. Despite these measures, runs have declined, primarily due to low river flows, poor fish passage conditions, and overfishing. Under established water rights, it is impossible to increase flows for fish without new storage to capture unappropriated flows. Resident fish resources are also augmented by stocking programs and, assuming this continues, there will continue to be a good fishery. Several species of big game are also present. Streams, lakes and reservoirs, forests, mountain scenery, and fish and wildlife resources attract heavy recreation use, requiring additional recreation lands and facilities.

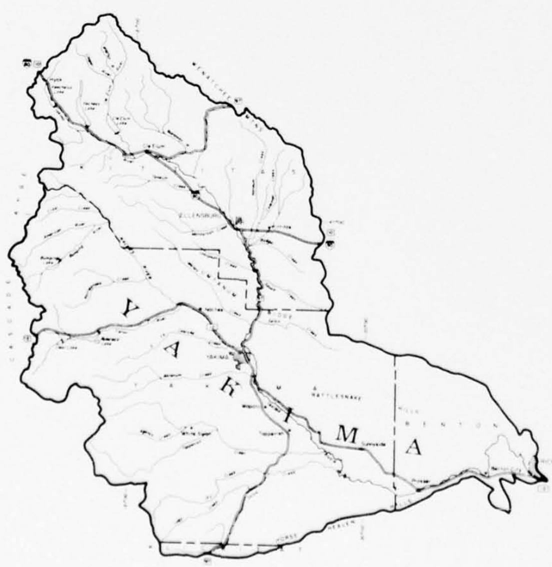
Flow augmentation of the Yakima River is needed to abate temperature and nutrient problems and to provide additional irrigation water supplies. Water supplies for development of Indian Reservation lands are also needed.

Alternatives for satisfying water supply and water quality needs include adjusting the operation of existing reservoirs in combination with additional upstream storage, interbasin diversion from the Columbia, Snoqualmie, Cowlitz, or Klickitat Rivers, and capture of agricultural return flows to reduce pollution of the Yakima River. Irrigation alternatives include limiting irrigation to available water supplies under current conditions.

The problems are complex and require interdisciplinary studies beyond the scope of this study. Solutions involve satisfying water rights of the Yakima Indian Reservation and others. Flood damage reduction alternatives considered varied from management to structural measures. After analysis of the alternatives, the following solutions were selected for the purpose of this framework study on the basis that these elements could be modified in future detailed investigations.

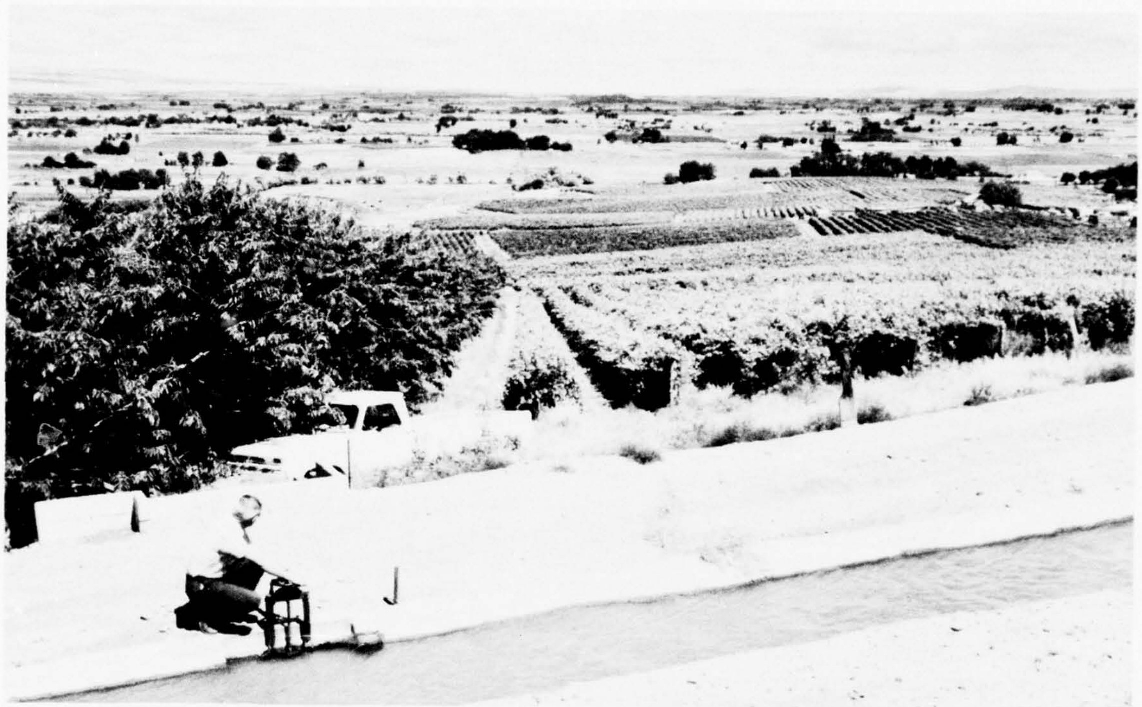
Development of the flood plain would be regulated by Kittitas, Yakima, and Benton Counties to reduce future damages by controlling potential urban expansion onto the flood plain. Structural measures would include more than 61 miles of levees along the Yakima and Naches Rivers.

Flooded farmland near Union Gap, Washington, on the Yakima River (USCE).



To meet food and fiber requirements, 101,000 acres of dry land would be irrigated and supplemental water furnished to 106,000 acres. This would require about 777,000 acre-feet of new storage at Bumping Lake and other sites, including 60,000 acre-feet on the upper Klickitat River in Subregion 7. Diversion from this latter storage along with ground-water pumping and reuse of return flows, would meet irrigation needs on the Yakima Indian Reservation. About 150,000 acre-feet of this supply for non-Reservation lands could be developed by an interchange of storage between Kachess and Cle Elum Reservoirs, or a diversion from the Cowlitz River in Subregion 8, into the existing Tieton Reservoir and development of 100,000 acre-feet of storage on the Little Naches River above its confluence with the American River. An alternative to the Cowlitz River diversion would be diversion of water from the Columbia River and development of irrigable lands now held by the Atomic Energy Commission near Hanford. Also, cooling waters from future thermal electric powerplants at Hanford could be pumped up onto lands in the Moxee Valley. Detailed studies are required to evaluate the best possible alternative.

Three hundred twelve miles on 10 streams should be studied to determine whether they should be included in a state or national system of recreation or scenic rivers. Lakes and reservoirs have a potential for accommodating all projected recreation needs through expansion of existing recreation and boat launching sites. Additional recreational opportunities near urban centers would be provided with new reservoirs such as the Tampico Reservoir just a few miles from Yakima.



Irrigated land in the area produces high quality fruits, vegetables, grain, and forage crops (USBR).

AREA B
SNAKE RIVER, SUBREGIONS 4, 5, & 6

The Area and Its Needs

The Snake River Area (figure 20) extends over nearly 108,000 square miles in the southeastern part of the region. It includes parts of the states of Idaho, Nevada, Oregon, Utah, Washington, and Wyoming. The most prominent landform is the Snake River Plain, which is bounded by ranges of the Rocky Mountains on the north and east, by the Blue Mountains on the northwest, and by the basin and range physiographic provinces on the south. The Snake River threads through this area from east to west for a thousand miles before entering the Columbia River in southeastern Washington.

The major water and related land resource developments have been centered around hydroelectric power generation and irrigation. The area has about 3,370 megawatts of generating capacity, either installed or under construction. Irrigation is being provided to some 4.2 million acres, resulting in a net depletion to the water supply of about 8.6 million acre-feet. This area is one of the few phosphate-producing areas in the United States. It is also of national significance with respect to its unique recreation resources which include national parks, wilderness, primitive areas, and wild rivers.

Although the Snake River Area has vast land resources and a reasonably abundant supply of water, the current and projected needs are also large. In some areas, conflicts already exist among several uses, especially recreation, fish, wildlife, and water quality on the one hand, and power development, irrigation, and flood control on the other. Other major problems needing attention include drainage, erosion and sedimentation, overgrazing, water management, logging and mining practices, improved fire protection, and flooding. The water is of relatively high quality, but problems of sediment and mineral loads, and bacterial contamination occur from time to time in some areas. Fishery problems are principally those associated with protecting anadromous fish runs and providing adequate stable flows of suitable quality to maintain a quality resident fishery. Wildlife needs include habitat preservation and improvement, especially big game winter range and waterfowl nesting areas. Additional water for both new and supplemental irrigation is critical, particularly in the Upper and Middle Snake Subregions. Supplemental water is needed for over 1 million acres of currently irrigated land; 13 million acres of dry land are potentially irrigable.

The projected resource needs for the Snake River Area are summarized in table 14.

FIGURE 20. Plan Formulation Area B

Table 14—Needs Summary, Area B
Columbia-North Pacific Region

Purpose or Function	Units	Current (1970) Development	Projected Gross Needs 1980	2000	2020	Residual Needs 1980	2000	2020
Water Development and Control								
Electric Power								
Capacity (Peak)	mw			Only Projected on a Regional Basis				
Energy	mil kwh			Only Projected on a Regional Basis				
Navigation								
Commerce	1,000 tons	470	1,800	3,600	6,700	1,330	3,130	6,230
Water Quality Control								
Raw Waste Production 1/	1,000 p.e.	5,481	7,586	11,411	15,377	2,105	5,930	9,896
Waste Removal 1/	1,000 p.e	3,301	6,448	10,270	13,839	3,147	6,969	10,538
Municipal and Industrial Water								
Supply	mgd	386	494	712	969	108	326	583
Municipal	mgd	(134)	(173)	(265)	(374)	(39)	(131)	(240)
Industrial	mgd	(179)	(234)	(339)	(463)	(55)	(160)	(284)
Rural-domestic	mgd	(73)	(87)	(108)	(132)	(14)	(35)	(59)
Flood Damages								
Major Streams 2/	Ann. $1,000	2,762	-	-	-	3,914	6,063	9,894
Bank Erosion 2/	Ann. $1,000	2,650	-	-	-	2,796	3,006	3,410
Area Flooded 2/	1,000 ac	338	-	-	-	338	338	338
Irrigation								
Total Irrigated Area	1,000 ac	4,226	5,310	5,700	6,440	1,084	1,474	2,214
Water Short Area	1,000 ac	(1,030)	-	-	-	(1,030)	(1,030)	(1,030)
Water Supply	1,000 ac-ft	20,996	26,273	27,694	30,508	5,277	6,698	9,512
Water and Related Land Programs								
Fish and Wildlife								
Commercial Fishery 3/	1,000 lbs.	-	-	-	-	-	-	-
Sport Fishing	1,000 days	2,177	3,084	4,089	5,328	907	1,912	3,151
Resident Species	1,000 days	(2,001)	(2,781)	(3,688)	(4,802)	(780)	(1,687)	(2,801)
Anadromous, Marine, Shell	1,000 days	(176)	(303)	(401)	(526)	(127)	(225)	(350)
Hunting	1,000 days	3,446	4,168	5,404	6,910	722	1,958	3,464
Water Related Recreation								
Development	1,000 rec days	13,900	22,100	42,700	78,400	8,200	28,800	64,500
Required Surface Water Use 4/	acres	35,000	46,300	86,500	158,200	11,300	51,500	123,200
Land Area (Rec. Facility Develop.)	acres	5,900	11,900	20,100	35,600	6,000	14,200	29,700
Pleasure Craft	no. (1,000)	30	39	72	133	9	42	103
Watershed Management								
Flood Damages—Minor Streams 2/	Ann. $1,000	12,336	-	-	-	16,184	19,605	23,294
Area Flooded 2/	1,000 ac	683	-	-	-	683	683	683
Erosion and Sediment Control	1,000 ac	7,733	12,164	18,467	24,558	4,431	10,734	16,825
Drainage	1,000 ac	162	285	397	536	123	235	374
Beach Erosion Control	miles	-	-	-	-	0	0	0
Bank Stabilization	miles	872	2,144	5,335	7,580	1,272	4,463	6,708
Levees and Floodwalls	miles	152	450	954	1,544	298	802	1,392
Channel Improvement	miles	1,410	3,359	6,691	9,639	1,949	5,281	8,229
Protection and Management 5/	1,000 ac	46,355	54,483	55,074	55,280	30,128	30,717	30,925
Water Conservation	1,000 ac	4,100	5,175	5,539	6,254	1,075	1,439	2,154
Water Yield Improvement	1,000 ac	0	39	90	146	39	90	146
Related Land Production								
Crop	1,000 tons	14,912	20,445	27,113	36,035	5,533	12,201	21,123
Irrigation	1,000 tons	(12,011)	(17,334)	(23,473)	(31,333)	(5,323)	(11,462)	(19,322)
Dryland	1,000 tons	(2,901)	(3,111)	(3,640)	(4,702)	(210)	(739)	(1,801)
Forest Wood Fiber	mil. cu. ft.	343	383	454	504	40	111	161
Range Grazing Capacity	1,000 aum	4,116	4,774	5,697	6,261	658	1,581	2,145

1/ Includes municipal, industrial, and recreation use.
2/ 1970 needs over 1970 level of flood prevention.
3/ Not estimated, commercial fishery is negligible.
4/ Needs are a function of recreation day requirements.
5/ Includes recurrent programs that will require acceleration with implementation of a plan. Residual needs cannot be determined by subtracting current development from gross needs as many of these practices are applied annually on the same areas.

Formulation of Area Plans and Programs

In the Snake River Area there are numerous alternatives for meeting projected water and related land needs; but, in several instances, the satisfaction of some requirements would conflict with other uses and objectives. Major alternatives considered, the plan or program evolved, and the reasons for its selection are summarized by basins or subareas. In some places additional studies beyond the framework level are necessary before a plan can be selected.

Water resource planning in this area must consider all rights to the use of water, including those established by treaties with the Nez Perce and the Shoshone-Bannock Indian Tribes, and by the executive order establishing the Duck Valley Indian Reservation.

The Idaho Water Resources Board requested that the following statement be included for the Idaho portion of this area: *"A comprehensive plan has not evolved for the State of Idaho. The Idaho Water Resource Board, representing the State of Idaho in water resources planning functions, determined that a full comprehensive water resources plan for the state should not be fixed at this time. Many ongoing studies, such as Joint State Wild and Scenic Rivers Study, USDA Type IV Studies, the Western United States Reconnaissance Study, and the Columbia River Tributary Study will provide additional information on resource use. Therefore, Idaho has elected to delay formulation of a plan, however, alternatives have been identified and, where possible, studies have been outlined that would resolve conflicts and/or would assist in the selection of a plan between competing uses."* The use of the word "planned" in this document does not imply that a fixed plan has been developed.

Main Stem Snake River

Because the Snake River is the major source of surface water for the area, a discussion of the main stem is necessary before considering the various subareas.

Three main stem reservoirs with a combined capacity of nearly 4 million acre-feet, provide major regulation in the upper basin and furnish irrigation storage for thousands of acres in Idaho. However, average or above runoff cannot be fully controlled. In dry years, reservoir-related recreation and environmental values suffer as a result of drawdown to satisfy irrigation rights. This latter problem is especially critical at Jackson Lake, located in Grand Teton National Park. Possible solutions could involve increased use of ground water, new surface storage, or some combination of the two. Storage sites exist that could replace Jackson Lake storage. Development of these sites could furnish recreation and a resident fishery, improve flows, and store water for flood control, power, and irrigation, but some involve prime fish and wildlife habitat or have other potential uses. There is also disagreement

between Idaho and Wyoming as to where the new storage should be located; Wyoming interests preferring that it be located in Idaho, and Idaho preferring the opposite. Major ground-water development of the Snake Plain Aquifer could also assist in meeting demands and reduce the frequent and excessive reservoir drawdown.

Water quality problems are relatively minor in the upper part of the basin, but major population centers and industries at Idaho Falls, Blackfoot, and Pocatello discharge heavy waste loads into the river (figure 21). Water quality problems are frequently aggravated by a combination of heavy waste loads and diminished flows, particularly below Blackfoot. Heavy algal growth in American Falls Reservoir has resulted in wide diurnal fluctuations in dissolved oxygen concentration. This condition is further aggravated by municipal and industrial waste loads in the Portneuf River which empties into the head of the reservoir. At Milner Dam, the flows are essentially depleted by irrigation diversions in summer months of dry years. The canyon below Milner is relatively inaccessible and does not provide a good stream fishery even in good water years, so recreation uses are not affected significantly by diversions. Good water quality is generally maintained down to Milner Dam in summer months of most years by large flows carried in the river. After the irrigation season, when flows are reduced to fill upstream storage, waste loadings cause a critical water quality problem in Milner Reservoir. Flows could be augmented from storage, ground-water pumping, and improved water management.

FIGURE 21. Major Pollution Sources in the Upper Snake Basin

About 50 miles below Milner Dam, outflow from the Snake Plain Aquifer at Thousand Springs establishes essentially a new river of excellent quality and relatively stable flow. Irrigation diversions at this point would require pump lifts exceeding 500 feet to reach suitable lands. Large capacity multiple-purpose storage in this reach would reduce pump lifts and provide irrigation water for several hundred thousand acres of high quality land, primarily on the Bruneau Plateau, and serve other functions. However, the

storage would inundate very attractive scenic areas, large fish hatcheries, powerplants, river pumps, and other developments. Therefore, major storage is not considered feasible in this stretch. Other alternatives are: pumping floodflows and surplus streamflows into offstream storage; limited expansion of direct river pumping to adjacent lands, primarily on the Bruneau Plateau; local ground-water pumping as the aquifer is recharged with surface supplies; transbasin diversions and exchanges with the Boise and Payette Rivers; an extensive canal system from Milner Dam to the Bruneau lands in connection with exchange ground-water pumping; water savings upstream; or meeting food and fiber needs elsewhere.

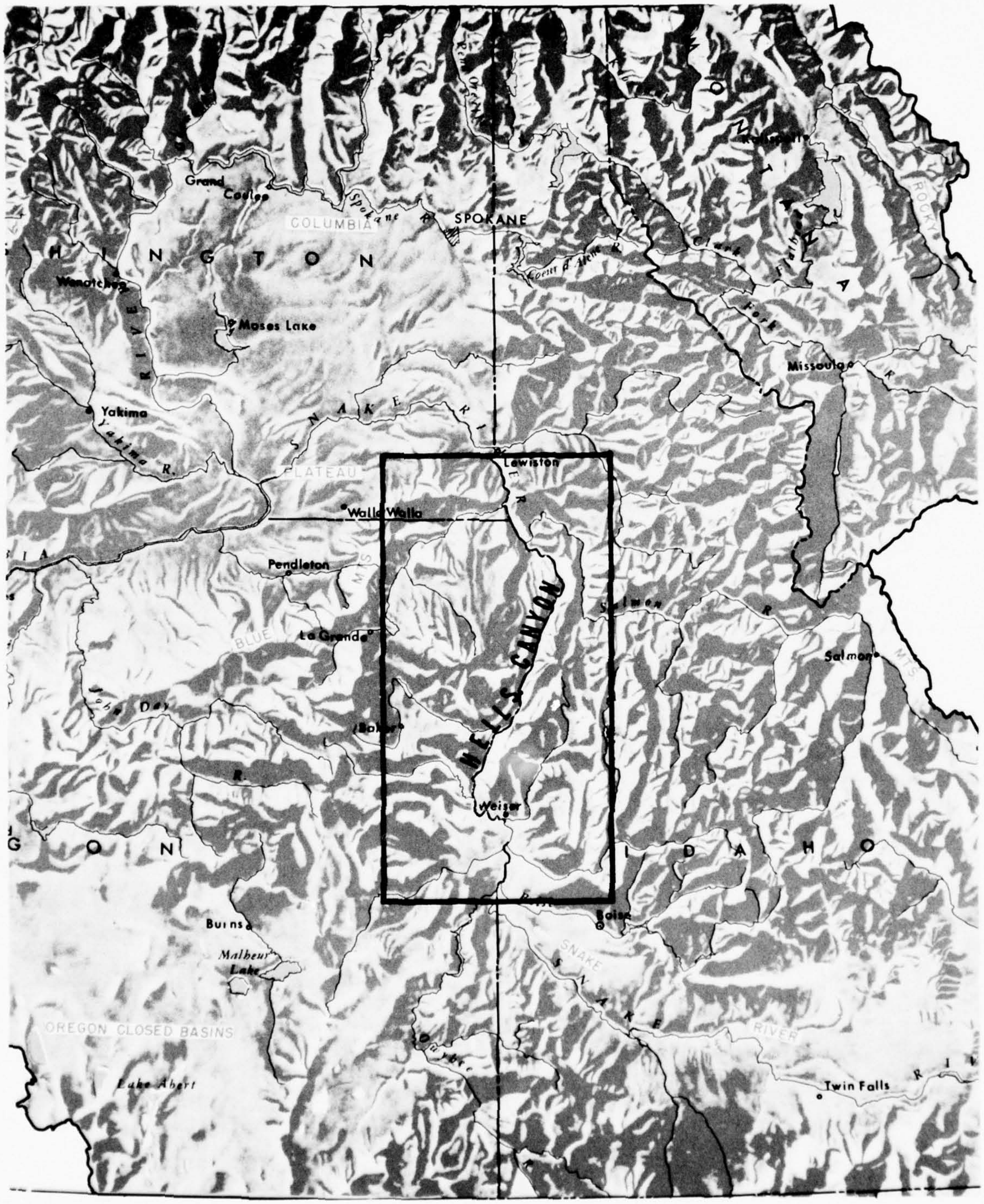
Part of the alternative for effecting the Snake River-Boise River water exchange includes a dam in the Swan Falls area. The impoundment which would replace the existing Swan Falls Dam and powerplant would provide increased hydroelectric power generation and serve growing recreational demands of the populated areas nearby. Minimum flows for fish and water quality could also be maintained in the Boise River by pumping from the Snake River.

The Boise, Payette, Owyhee, Malheur, and Weiser Rivers, which join the Snake River in Subregion 5, add greatly to the flow of the Snake River, but also contribute water quality problems. These problems could be partially solved by measures in the individual streams.

There are several locations from which Snake River water could be pumped to large acreages of potentially irrigable land in Idaho's Boise and Bruneau Basins and to Oregon's Owyhee, Malheur, Powder, and Burnt Basins. The reach just west of Weiser upstream to Nyssa is the primary one in Oregon, due to the elevation and relatively stable pool of Brownlee Reservoir.

Brownlee, Oxbow, and Hells Canyon Dams, which effectively harness the large flows and drop in elevation in about a 95-mile reach of the Snake River, have an installed hydroelectric power capacity of 942 megawatts. Planned additional units at Brownlee and Oxbow Dams would add 228 MW. However, the ultimate capability of these three sites, assuming 2020 loads and resources, is 1,300 megawatts of installed capacity.

The reach from Hells Canyon Dam to its confluence with the Grand Ronde River is a unique scenic area with great attraction for recreational pursuits. Minimum flows of 9,500 cubic feet per second, or the inflow to Brownlee Reservoir, whichever is less, have been suggested for the reach from Hells Canyon Dam to the Salmon River, as well as a reduction in water-level fluctuations, to preserve and enhance recreational boating and other associated instream purposes. Considerable public interest has been expressed to retain this area as a wild river. If the proposed minimum flow of 9,500 cfs at Weiser is established without tying to the inflow to Brownlee Reservoir, this action would preclude nearly all future consumptive use development upstream and also reduce power production at the three existing hydroelectric plants below Weiser.


Grand Coulee
Spokane R.
SPOKANE
COLUMBIA
H I N G T O N
Wenatchee
RIVER
Moses Lake
Yakima
Yakima R.
S N A K E R I V E R
PLATEAU
Lewiston
Walla Walla
Pendleton
BLUE
MTS
La Grande
John Day R.
Baker
HELLS CANYON
Weiser
G O N
I D A H O
Salmon
Salmon R.
Missoula
Coeur d'Alene R.
Clark Fork
ROCKY
MTS
Boise
Burns
Malheur Lake
OREGON CLOSED BASINS
Lake Abert
SNAKE RIVER
Twin Falls

If the decision is made eventually to provide a minimum flow of 9,500 cfs or more, means will have to be identified to provide the necessary water. One alternative, with several variations, is to divert Salmon River water to southern Idaho, but this could conflict with instream fishery needs of the Salmon River. Other alternatives are extensive ground-water pumping, improved water management, new surface storage, or some combination of these.

The reach below Hells Canyon Dam also has potential for additional major hydroelectric power development, and numerous plans have been developed involving one or more dams at various locations. Each plan attempted to minimize adverse effects on anadromous fish and other environmental issues. The controversy has now been dampened somewhat with a proposed moratorium which would prohibit any type of development until after 1980. The Federal Power Commission has under consideration a recommendation to permit development at the end of a 5-year period. Also the Secretaries of Agriculture and Interior have recommended a study of this reach to determine if it should be included in the national wild and scenic river system. The State of Oregon intends to initiate activities to reevaluate that state's policy regarding development of this reach of the Snake River.

Below Lewiston, the Snake River is highly developed, with a series of four dams regulating flows primarily for navigation and run-of-the-river hydropower production. The pool of Lower Granite Dam, the uppermost of these four dams, extends a few miles above Lewiston. The initial installed nameplate capacity of the four sites is 1,485 megawatts; the ultimate capacity can be increased to 3,033 megawatts. With the larger capacity, the plants would be used more for peaking purposes. Asotin Dam, authorized for construction by the 1962 Flood Control Act, would be located at the head of Lower Granite pool. It would have an ultimate capacity of 540 megawatts; with the addition of a lock, commercial navigation would be extended some 30 miles upstream from Lewiston.

There is considerable state and local opposition to constructing Asotin Dam because of its potential impact on the Snake and Salmon Rivers' anadromous fish runs. The primary alternative to its construction is nondevelopment, extending the scenic and wild river status of the Hells Canyon reach downstream to Lewiston, Idaho. The framework plan does not contain any recommendations except for future studies to select the optimum use of this reach. Asotin Dam and powerplant, which is in a deferred category, is not included in the plan.

The elevated pools created by the four dams on the lower Snake River will facilitate irrigation development on adjacent lands. By 2020, a total of 133,000 acres are projected for development by river pumping.

Opportunity exists for development to enhance water-oriented recreation on the reservoirs. With development of adjacent lands to furnish feed near large bodies of water, waterfowl hunting is expected to gain in importance, along with hunting of upland game and trapping of fur-bearing animals.

Erosion, particularly on dry cropland, is a significant source of pollution for the lower Snake River as the adjoining area has the highest sediment yield of any subbasin in the Pacific Northwest. The only apparent solution is careful land treatment and watershed protection.

The discussion now will focus on the various subareas through which the Snake River flows, beginning at the headwaters and continuing downstream to the mouth.

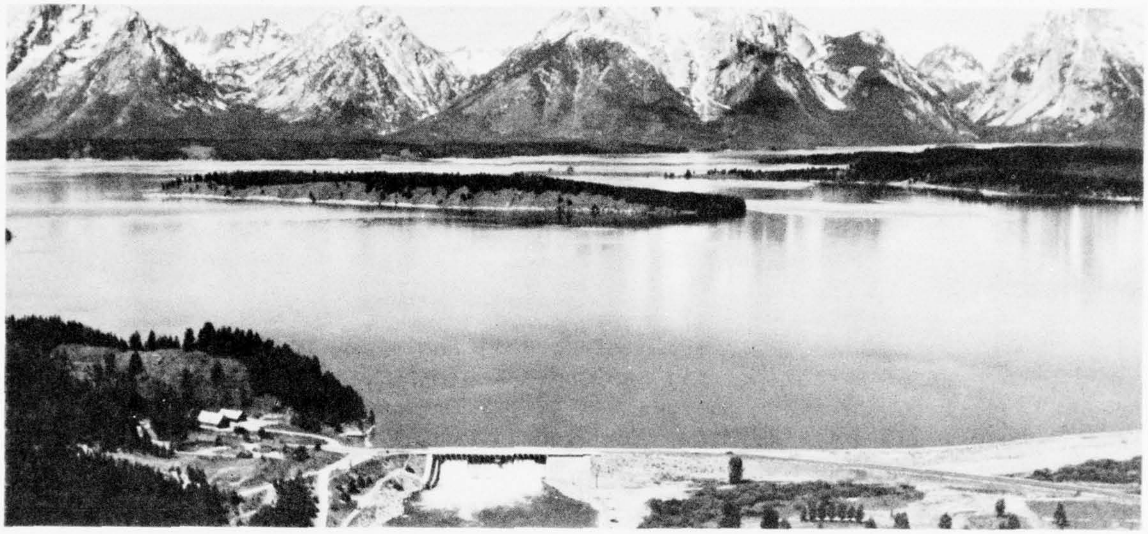
South Fork Subarea (Subregion 4)

The South Fork Subarea, which contains part of Yellowstone National Park and all of Grand Teton National Park and adjacent national forests, is of major importance for esthetic values and recreational pursuits. Most of these unique lands and streams have been identified in the framework plan as being particularly suited to meet a significant portion of the recreation, fish, and wildlife needs. Consequently, structural developments in these areas should be limited and, where needed, should be designed to minimize environmental conflicts. Most of the streamflow is committed for use downstream, but the 4 percent that has been reserved through the Snake River Compact for use in Wyoming is sufficient for all identified in-basin needs.

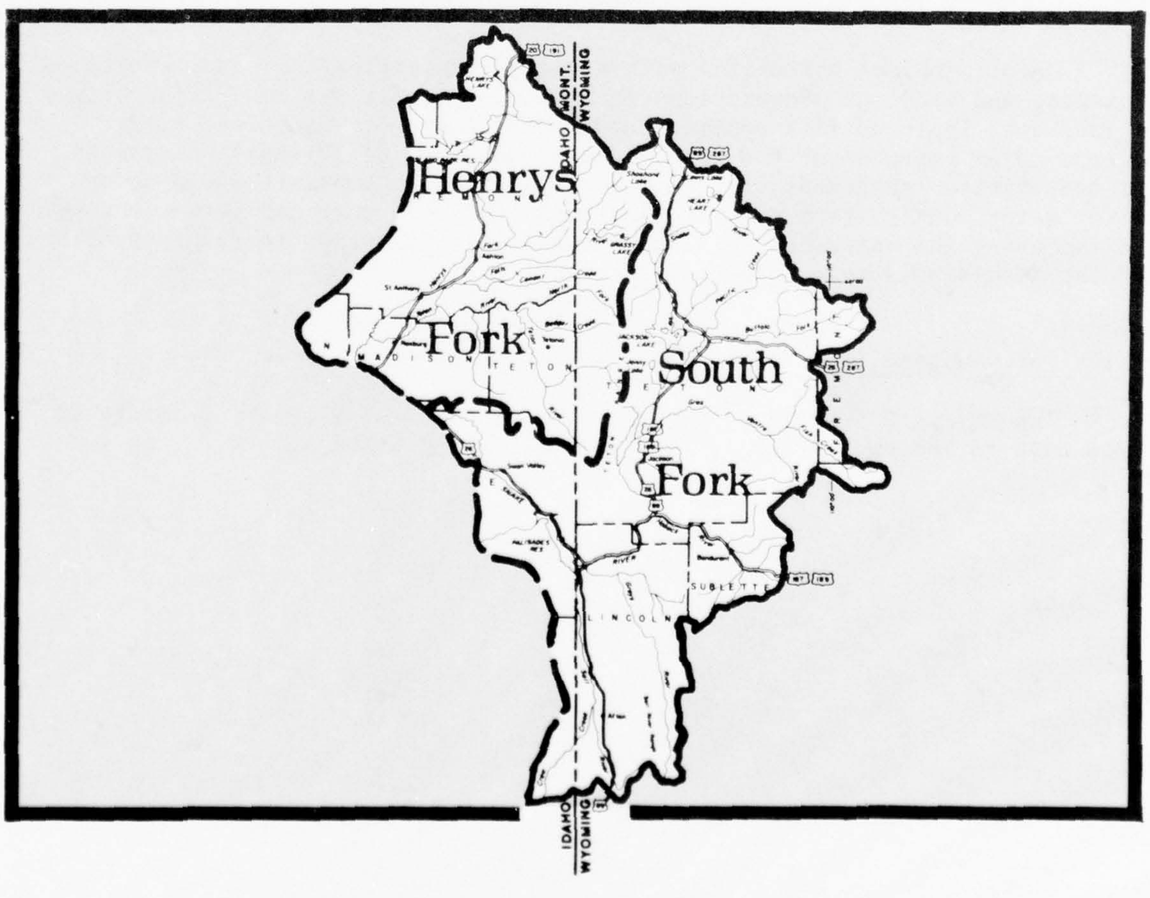
Although water quality problems are relatively minor at the present time, increasing visitor use at Grand Teton National Park and housing construction in Jackson Hole may cause contamination. Treatment of these and other municipal and industrial waste loads is included in the plan. Water supplies for both the recreation population and the municipal and rural-domestic needs would be provided through extension of existing systems, using ground water or surface supplies.

Irrigation development, which is scattered mostly along the alpine valleys, depends largely on unregulated runoff, and more storage is needed if late-season supplies are to be made available to most of the 113,000 acres of inadequately irrigated land. However, there are significant conflicts in the South Fork Subarea between construction of major storage facilities and preservation of natural environment. The major conflict centers around the need for replacement of 640,000 acre-feet of Jackson Lake storage, as discussed in the section, Main Stem Snake River. In general, large-scale irrigation and storage development would be bypassed in favor of recreational and environmental enhancement. The plan does include the construction of two multiple-purpose storage facilities on Crow and Spring Creeks in Wyoming, but there may be an adverse effect on the Idaho fishery as a result of storage on Crow Creek.

Consideration should also be given to storage on Jackknife Creek in Idaho. With a total storage capacity of 30,400 acre-feet, this would control flooding and furnish water supplies for 1,200 acres of new irrigation and



Jackson Lake in Wyoming with the Grand Teton Range in the background (USBR).



29,900 acres of water-short land along Salt River. Consideration should also be given to major storage alternatives in Idaho or Wyoming of approximately 1,620,000 acre-feet to regulate flows on the Snake River for water use downstream, to help provide minimum flows for fisheries and water quality, and to provide power generation and much needed flood control.

Flooding of lowlands is a frequent problem along the Snake River at Jackson Hole and along the Salt River in Wyoming. Flood plain zoning and 10 miles of channels and offset levees would be key features of the plan for the Jackson Hole area. Storage appears to be the only means of preventing significant flood damage in the Salt River Valley.

The plan identified 310 miles of streams for study to determine if they should be a part of a state or national system of recreation streams. The streams identified for study include all or parts of the Snake, Salt, Gros Ventre, Hoback, and Greys Rivers. The free-flowing reaches of the Snake and Gros Ventre Rivers above Palisades Reservoir have already been selected for study under section 5(d) of the Wild and Scenic Rivers Act. The State of Wyoming has taken the position that it is the State's responsibility to administer the rivers within its boundaries, and that development of scenic rivers programs and other similar programs affecting the waters of Wyoming should be under its jurisdiction.

Major problems associated with cropland are irrigation water shortages, drainage, and erosion. Forest land needs include reforestation, timber stand improvement, improved fire control, and runoff control. Rangeland needs include cover improvement and revegetation. Studies of 17 small watersheds for cooperative management are included in the plan. Emphasis would be on better water conservation practices, stabilizing road cuts and stream channels, and improving the watershed through vegetative manipulation to reduce erosion and the resulting stream pollution.

Henrys Fork Subarea (Subregion 4)

The Henrys Fork Subarea covers the northeastern tributary drainage in Idaho down to the confluence of the Henrys Fork and Snake Rivers. This sub-

area, near Yellowstone and Grand Teton National Parks, has scenic mountains in the eastern and northern portions with broad irrigated valley bottoms and dryfarmed rolling upland plains in the central and southwestern portions. Some 215,000 acres are presently irrigated and over 280,000 acres of dry land are potentially irrigable. However, large parcels of these lands are now used as migration routes or habitat for big game and other wildlife; the limited number of major storage sites are also located in prime wildlife habitat areas. Therefore, only a moderate amount of additional irrigation should be considered. Although the streamflow is fully committed to downstream users in dry years, there appears to be adequate flow to meet identified consumptive needs.

To fully control floods with storage, about 70,000 acre-feet of additional flood control space would be required on the Henrys Fork above St. Anthony. An alternative would be to divert floodflows of the Henrys Fork above St. Anthony to a recharge area on the Snake River plain. In selecting recharge sites, consideration should be given to not affecting the sage grouse migration corridor between Quayles Lake and Hamer. Channelization and levee works along the lower 5 miles of Henrys Fork could reduce flood damages in the general area by more than half, but would dry up adjacent wetlands used by waterfowl. These works and the authorized storage on Teton River could virtually eliminate flood damage on lower Henrys Fork. Local zoning of flood plains to restrict development near the towns of Teton, Sugar City, and Rexburg could help to minimize flood losses.

The quality of surface water is relatively high, but some measures are necessary to insure its continued high quality. These would include municipal and industrial waste treatment and erosion control measures on cropland to stabilize or reduce silt loads in streams. Continued land treatment measures are needed on all lands. Problems include: erosion--about 182,600 acres, mostly dry cropland; wetness--44,200 acres; and flooding--34,000 acres. Cooperative treatment is needed on 19 watersheds to help relieve these problems. It is also important to protect the Snake Plain Aquifer from contamination if artificial recharge is practiced. Filtering and settling basins or similar measures may be required for this purpose. In addition, effluent from the

city of Rexburg now entering the South Fork Teton River should be transported to a land disposal area. There is an ample supply of ground water to satisfy all projected needs for municipal, industrial, and rural-domestic use.

The major part of the water supply for irrigation will come from Teton Reservoir (now under construction), from natural flows in wet years, and from ground-water development. Teton Reservoir will supply some 37,000 acres of new irrigation; ground-water development is expected to serve an additional 20,000 acres.

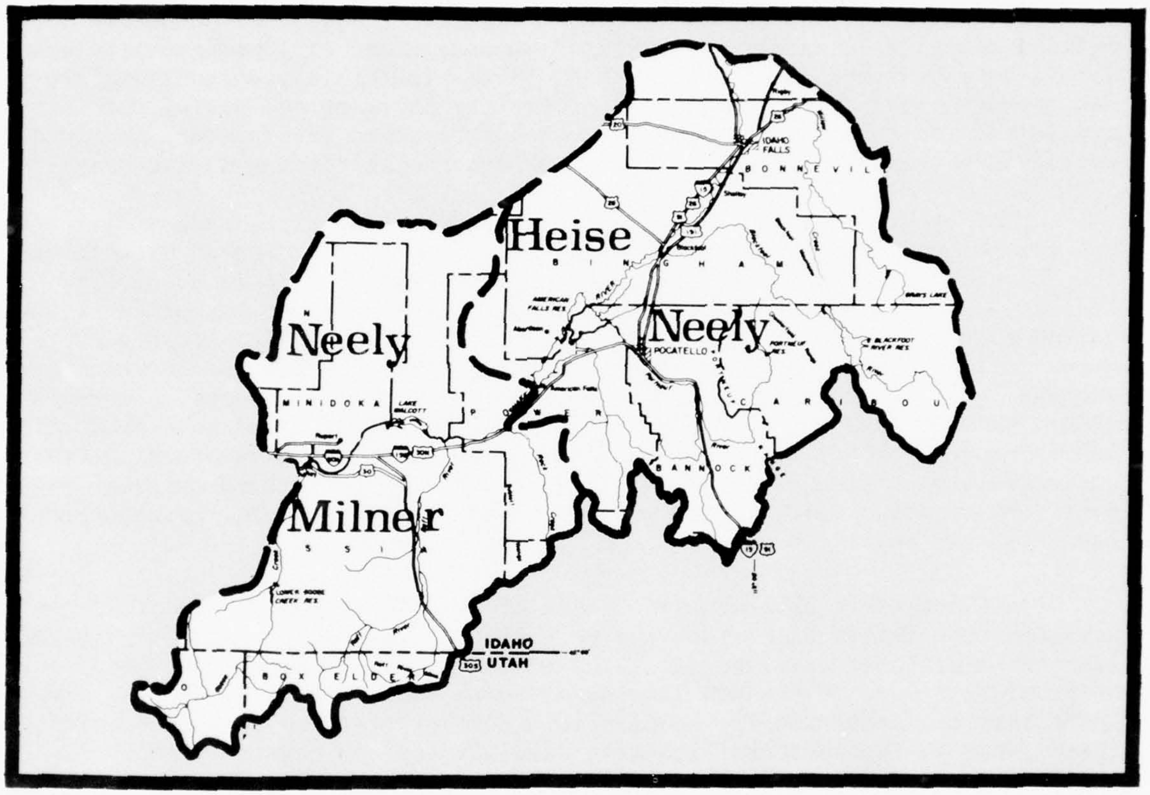
Construction of multiple-purpose storage on Boone and Squirrel Creeks with a total capacity of 10,000 acre-feet should be considered to irrigate 3,100 acres of new land, supply supplemental water to 3,000 acres, reservoir-related recreation, and flood control. Consideration should also be given to construction of a 3,600 acre-foot storage facility on Teton Creek to provide recreation and supplemental water for 3,400 acres of inadequately irrigated land. Ground-water pumping could supplement irrigation water supplies for 27,800 acres.

Some 65 miles of the Henrys Fork from Warm River to Big Springs have been designated for study under section 5(d) of the Wild and Scenic Rivers Act. Other studies should also be made to determine requirements for managing scenic roads, lakes, reservoirs, and unique, natural, historical, and archeological resources. Construction of a fish hatchery and 2 miles of artificial spawning channels should be considered. These, along with spawning bed and stream improvement, nongame fish control in streams and lakes, and improvement of lakes, would do much to enhance the fisheries of this area. Wildlife habitat improvement should consist of improving winter range in the foothill areas for both big game and upland game by providing adequate vegetative cover and fencing. Nesting facilities and feeding areas should be developed to enhance waterfowl population.

Heise-Neeley Subarea (Subregion 4)

The southeastern half of the Heise-Neeley subarea is composed of high, rolling hills and broad valley bottoms; valleys to the east are prime winter wildlife habitat, but those in the western portion are highly developed for irrigation. The northwestern half includes a large irrigated area adjacent to the Snake River. Farther west are areas irrigated by pumping from the Snake Plain Aquifer. The western edge of the subarea is exposed lava beds and desert rangelands.

Flows of the Snake River in this reach are substantial and are augmented in many months from upstream storage. However, the water is heavily committed, especially in dry years, to use here and in areas farther downstream. In wet years, however, a large amount of water is available for additional uses. Tributary streams cannot provide much, if any, water for new developments, but



there is an abundant supply of ground water which could be used to fulfill needs. However, if heavy use is made of the aquifer, recharge would probably be required. Water-saving opportunities on existing irrigation developments should also be considered. All water rights, including those of the Fort Hall Indian Reservation, must be considered in planning for this subarea.

Major population centers as well as industries at Idaho Falls, Blackfoot, and Pocatello discharge heavy waste loads into subarea streams; however, these cities and industries are taking steps to meet required levels of treatment. Pollutants from return flows and normal runoff, together with low flows, also aggravate the water quality problem, particularly below Blackfoot. A combination of measures such as increased waste treatment, land treatment, erosion control, water savings, and flow augmentation should be considered for water quality purposes. Using ground water to irrigate new lands could also provide added summer flows and improve water quality in the Snake River below Blackfoot.

This area has some of the greatest erosion problems in eastern Idaho, encompassing over 762,000 acres of mostly nonirrigated cropland. In addition, about 101,000 acres have wetness problems, and some 184,000 acres are subject

to flooding. Cooperative land treatment should be considered on nearly 1.8 million acres in 20 watersheds. Rangeland management at lower elevations should be to control livestock grazing; in the foothills and at higher elevations, management should be concerned with protecting big game and upland game habitat and increasing its carrying capacity. New irrigation developments should also include features to protect, mitigate, or enhance wildlife and fish populations.

Few opportunities exist for meeting recreation, fish, and wildlife needs, but several measures of importance should be considered. The 53-mile reach of the Portneuf River from its origin to Inkom and the 20-mile reach of the Blackfoot River from its origin to Blackfoot Reservoir have been identified as having potential recreational value, but sufficient streamflow is needed to provide fish habitat and good water quality. Strategically placed wells could furnish these flows in dry periods and supply other requirements. There is also a need to enhance the production of waterfowl and upland game by developing an exchange water supply of 7,400 acre-feet, to permit maintaining Grays and Market Lakes at a constant level. However, the authorized enlargement of Blackfoot Reservoir or local pumping from ground water probably cannot provide the necessary water.

Although this subarea already has prominent irrigation, considerable potential for future expansion remains. Some 226,800 acres of new irrigated land and additional water supplies for 53,800 acres of water-short land could be provided. Some of the new land development would depend on leasing arrangements with the Atomic Energy Commission. Further study is needed to select these lands so that any conflict with wildlife and environmental values is avoided. A 12,000 acre-feet storage facility at the Beacon Site on Bannock Creek could provide flood control, recreation, and irrigation water. With this storage, 1,900 acres of new irrigation could be developed and 600 acres of water-short irrigated lands provided a supplemental supply. An additional 13,000 acres could be developed from existing surface supplies in the Fort Hall area. Consideration should also be given to the possibility of providing an additional 74,200 acre-feet of storage capacity at three sites on Garden, Hawkins, and Marsh Creeks. Although primarily to control floods, this storage would also provide some recreation and supplemental irrigation water for 6,200 acres. Local ground-water pumping should be considered for 202,100 acres of new irrigation. Also, 9,800 acres of new irrigation and 47,000 acres of supplemental irrigation could be secured from a combination of storage, diversion from tributary streams, and exchange ground-water pumping.

A significant increase in requirements for municipal and industrial water has been projected. There is sufficient ground water to meet these and the rural-domestic demands.

Channelization and offset levees along 4 miles of the Portneuf River near the towns of Bancroft and Lava Hot Springs, and 4 miles of local protection works on the Blackfoot River at Blackfoot could reduce flood damages. Recharge facilities in conjunction with zoning would reduce flood damages

along the Snake River and at the mouth of the Blackfoot River, but filtering and settling basins should be used in connection with the recharge operations. Flood plain zoning should also be instituted in populated areas along Willow and Sand Creeks, and the Blackfoot and Portneuf Rivers. Modification of the 20 miles of existing levees in the Heise to American Falls Reservoir reach of the Snake River and an additional one mile on the Portneuf River in the vicinity of Inkom should also be undertaken. Ririe Dam, under construction on Willow Creek, will provide flood protection to Idaho Falls, Iona, Ammon, and surrounding farmland.

Neeley-Milner Subarea (Subregion 4)

The Neeley-Milner Subarea covers the Snake River and adjacent areas between American Falls and Milner Dam. The southern portion is composed of low mountains and broad valleys with an established irrigated agriculture adjacent to the Snake River. Recent lava flows cover much of the areas to the north. The lava beds do not support any measurable surface flow, and flows of the small tributaries on the south are mostly depleted before reaching the Snake River. At Milner Dam, an important diversion point, maximum flows are much in excess of current needs in some years. However, it would not be economically justified to regulate these flows to meet additional demands.

A high percentage of the irrigators have good natural flow and storage rights and generally receive adequate supplies. However, critical ground-water areas have been declared by the State of Idaho in the Raft River and Oakley Fan areas because of the declining ground-water levels. Adjacent to the developed lands are extensive areas of high quality land with good potential for irrigation development, but local water supplies are limited. In order to provide additional irrigation water and meet instream Snake River requirements, it would be necessary to develop new water supplies from a combination of sources. These would include pumping excess Snake River natural flows, pumping from Snake Plain Aquifer and local aquifers as recharge from new irrigation builds up local ground-water tables, saving water by lining canals in the adjacent irrigated areas to reduce losses, and new upstream storage.

Water quality problems are serious during the winter when streamflows are reduced by storage rights concurrently with heavy waste loadings. Although waste loadings could be reduced with treatment, winter flows would still need to be augmented. There is sufficient runoff in about two-thirds of the years to provide adequate minimum streamflow as well as fill existing storage for the coming season; fluctuations in streamflow are shown in figure 22. In the remaining years, water quality flows would preclude the filling of reservoirs. Alternatives considered for providing additional irrigation water could also meet this need. By using existing storage and exchange ground-water pumping, low flows below Milner Dam could be augmented by nearly 180,000 acre-feet annually. This quantity of water, along with treatment of all municipal and industrial waste would provide the required level of quality. No additional

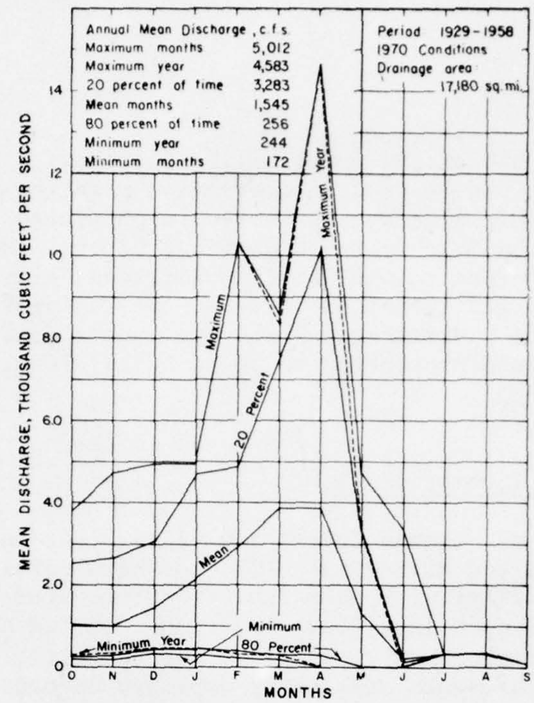


FIGURE 22. Monthly Discharge, Snake River at Milner, Idaho

ground-water installations would be needed to provide water quality flows, as the new irrigation wells could have sufficient capacity for these needs.

Serious erosion problems are experienced on about 838,000 acres of which nearly three-fourths are rangeland. Cropland has wetness problems on about 64,000 acres and local flooding on over 4,100 acres; cooperative treatment is needed on 13 watersheds. Most of the activity should deal with range management, water conservation and supply, streambank stabilization, erosion control, flood prevention, and drainage.

New irrigation development could include 61,200 acres in the Oakley Fan area using Snake River flows and storage supplemented by exchange ground-water pumping and local ground-water pumping. Supplemental supplies could also be provided for about 81,500 acres in the Raft River area. An additional 25,000 acres are expected to be developed using local ground water. Other irrigation could include development of 182,500 acres of new land and furnishing supplemental water for 66,600 acres of water-short land, mostly from a combination of natural flows, existing storage on the Snake River, and ground water. Alternative means of providing additional irrigation development include 7,000 acre-feet of storage on Rock Creek for 500 acres plus supplemental supply for 3,200 acres, 12,100 acre-feet of storage in four small reservoirs for 16,900 water-short acres in the Raft River drainage, and by diversion or pumping from the Snake River to irrigate 1,500 acres of new land. New storage, if developed, could provide some recreation and flood control as well as furnish late-season irrigation water.

There may be some possibility of geothermal power development in the Raft River drainage.

The 22-mile portion of the Snake River, from its confluence with Raft River upstream to American Falls Reservoir, was identified as having potential recreational value.

Northern Streams Subarea (Subregion 4)

The northern drainages extend west from the Henrys Form drainage to include the Big Lost River Basin. The landscape is composed of mountain ranges with broad valleys in the northern portion, timber-covered mountains in the west, and desert-rangeland with lava flows to the southeast. Numerous small streams, which originate in the mountains, sink into the lava beds of the Snake Plain Aquifer and contribute to the large outflow of Thousand Springs.

Croplands located along these northern streams are heavily irrigated in the early part of the growing season, but, because storage is lacking, most are water-short in the latter part of each season. Frequent flooding during spring runoff causes extensive damage to lands and improvements.

The small municipal and industrial water requirements could be provided from ground water, the quality of which is generally excellent. There are no known major waste loads in this subarea, but adequate treatment must be obtained for those that are produced in order to maintain the high water quality. Land treatment and erosion control practices to check rapid runoff and flooding would also reduce pollution from agricultural wastes and help maintain high stream quality. There are nearly 114,000 acres (about 60 percent rangeland) needing erosion control, nearly 18,000 acres with wetness problems, and almost 28,000 acres of cropland subject to flooding. Cooperative watershed treatment is needed on eight watersheds. Activities should be primarily associated with improving irrigation practices to conserve water, vegetative cover management, grazing management, erosion control, and flood prevention. The flood problems in the Mud Lake area could be partially resolved by raising and strengthening 9 to 12 miles of existing levees along the west and south shores of Mud Lake and on lower Camas Creek, and improving diversions into the lava beds.

Some opportunities exist for enhancing resources to meet fish, wildlife, and recreation needs. About 73 miles on Medicine Lodge Creek and Big Lost River are important for recreation purposes. This subarea also contains important wildlife habitat and migration routes; consequently, new irrigation should be limited to protect them. Total irrigation development considered for this subarea includes a water supply for 36,700 acres of water-short land and 100,500 acres of new land. Two storage facilities with a total capacity of 20,000 acre-feet could be developed on Medicine Lodge Creek above Middle

The Upper Big Lost River Valley in southeastern Idaho (Idaho Fish and Game Dept.).

Creek, and on Antelope Creek at the Lower Antelope site to furnish 21,000 acres with supplemental irrigation water. Storage of 24,000 acre-feet on Birch Creek would provide 6,500 acres of new irrigation and a supplemental supply to 2,200 water-short acres. Ground-water pumping could irrigate some 15,000 acres on the Medicine Lodge Fan, 12,000 acres in the Mud Lake area, 9,000 along the Big Lost River, 45,000 acres in the Birch Creek drainage, and 13,000 acres of dry land plus water for 13,500 water-short acres along Little Lost River.

The program for the northern streams could result in a few conflicts, the major one being that associated with the need for 12,000 acre-feet of storage on Medicine Lodge Creek above Middle Creek. This 27-mile stream has been identified as having potential recreation value. Development of storage here should be considered, and a study provided to examine alternatives available to help meet supplemental irrigation water needs.

West Side Subarea (Subregion 4)

The West Side Subarea includes tributary drainage areas north and south of the Snake River between Milner Dam and King Hill. The part south of the Snake River, which has large amounts of quality land and an excellent climate for agricultural production, is arid, and water supplies are very limited. The Snake River, which is often depleted in summer months at Milner Dam, is replenished by Thousand Springs in this reach. However, to reach the


Northern
Streams
West
Side
MONTANA
IDAHO
IDAHO
NEVADA
LEMHI
CLARK
CUSTER
BUTTE
BLAINE
CAMAS
GOODING
JEROME
TWIN FALLS
ELKO

main bodies of choice land southwest of Twin Falls with water from the Thousand Springs area, would require pump lifts of 500 feet or more and extensive canal systems. Small bodies of land near the river are being developed by river pumping, and some extension of irrigation by this method is expected to continue.

North of The Snake River are extensive, highly developed irrigated agricultural lands that are generally well supplied with water from storage and natural flows of the Big and Little Wood Rivers and Snake River and by pumping from the Snake Plain Aquifer near Thousand Springs. Increased groundwater pumping could provide an exchange supply for water-short land southwest of Twin Falls.

The northern part of this subarea, encompassing the Sawtooth Wilderness, the famous Sun Valley resort area, and portions of the Sawtooth and Challis National Forests, is very scenic and affords many excellent opportunities for recreation development. It supports a wide variety of wildlife and has numerous clear, cold streams and small lakes that support trout fishing and other recreational pursuits. Some 87 miles of stream have been identified as having potential recreational value. They include the Snake River below Twin Falls, Big Wood River above Magic Reservoir, North Fork Big Lost River, and all of Silver Creek. The programs identified for the West Side Subarea would have minimal conflicts. The picturesque region to the north would be virtually unchanged in terms of esthetic values. Offset levees could be used for flood control where channelization would destroy fish and wildlife habitat. Storage facilities could be located in areas where environmental impact would be limited and the additional irrigation would, for the most part, be extensions of present blocks of irrigation.

Implementation of measures described for the Neeley-Milner Subarea could correct water quality problems in the stretch of Snake River immediately below Milner Dam. The quality of Snake River flows is improved rather rapidly by inflow from Thousand Springs, and becomes very high by the time the river reaches King Hill. However, some build-up of water quality problems could occur in tributary streams without adequate waste disposal and control of runoff. Proper treatment of wastes, together with erosion and flood control measures, would prevent serious water quality problems.

There are major erosion problems involving 838,000 acres of mostly rangeland. Cropland problems include 55,000 acres with wetness and 70,000 acres with local flooding. Cooperative land treatment is needed on 22 watersheds, with the major emphasis on erosion control, water conservation, flood prevention, and drainage. Management of the mountainous area to the north should involve considerable erosion control. Management of rangeland should include managing key wildlife habitat more closely and improving hunting and fishing.

Channel and levee works should be considered for 24 miles along the Big and Little Wood Rivers. Along the upper Big Wood River, offset levees, a

Flash floods erode cropland causing deposition problems (SCS).

minimum of channelization, and heavy reliance on zoning should be considered to keep environmental, recreation, fish and wildlife losses at a minimum.

Development of 67,700 acres of new irrigated land and furnishing additional supplies to 49,400 water-short acres should be considered. The water-short lands, all south of the Snake River could be served from Snake River storage supplemented by exchange ground-water pumping and local ground-water pumping. Irrigation for 44,700 acres, primarily in the Salmon Falls and Deep Creek areas, could be supplied from the same sources. Water for the remaining 23,000 acres of new development in the Belle Rapids area south of the Snake River and west of Salmon Falls Creek could be pumped from existing flows of the Snake.

The plan would include additional units of the existing Bliss and Lower Salmon powerplants, construction of four small reservoirs in Nevada, and consideration of two more in Idaho, with a total capacity of 8,500 acre-feet. They would provide some flood control, recreation, and supplemental irrigation water. The four planned for Nevada would supplement supplies for about 2,300 irrigated acres; the two considered north of Snake River on Clover and Calf Creeks could provide water for about 3,000 water-short acres. An additional 15,000 acres in the Big Wood River drainage could receive supplemental ground water. No feasible means have been devised for providing full supplies to the remaining water-short lands.

Bruneau Subarea (Subregion 5)

The Bruneau Subarea includes the Bruneau River Basin and small south-side Snake River tributaries, including Succor Creek. It is characterized as a broad, sage-covered, gently sloping area dissected by several deep canyons which are particularly picturesque at higher elevations. The many scenic features include the Bruneau Sand Dunes, Bruneau-Jarbidge Canyon, and the Jarbidge Mountains and Wilderness. Because of its natural attributes, the entire main stem of the Bruneau River in Idaho is being studied under the Wild and Scenic Rivers Act. The Bruneau River drainage also includes a large area of strategic winter deer habitat.

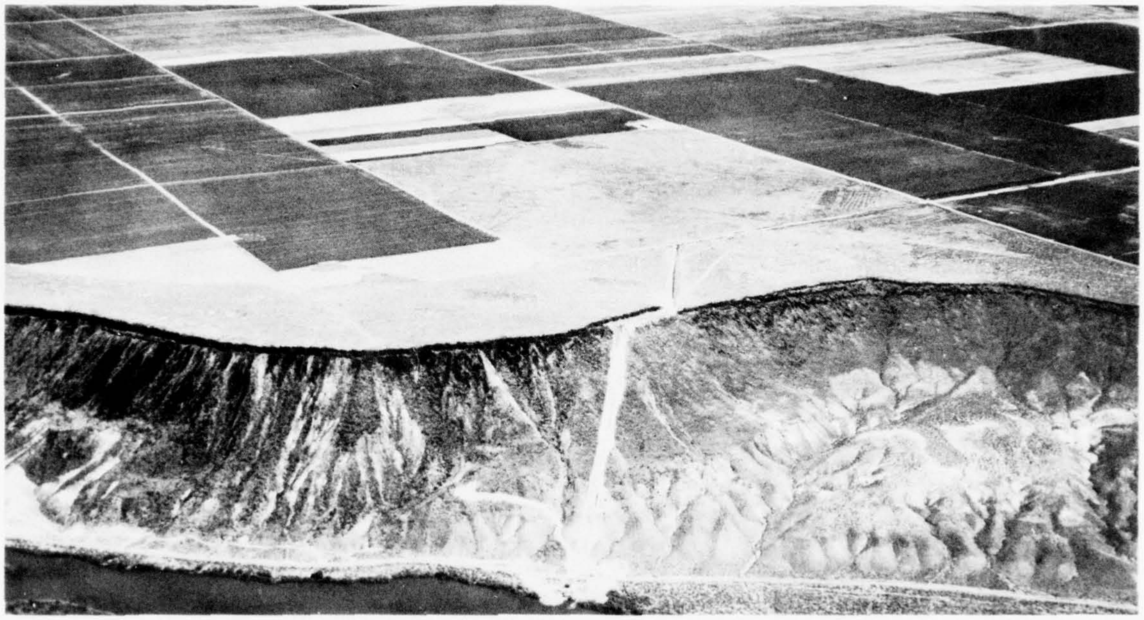
Runoff is erratic, resulting in late season water shortages every year and flood damages to agricultural land, roads, and other facilities in the early part of some years. Normally summer flow in the Bruneau River is warm, high in sediment and dissolved solids, and contains a high fluoride concentration.

The Grand View area has significant domestic water quality and pollution problems. This small community obtains its supply from ground water and disposes of part of its wastes underground where domestic systems can pick up the contaminated water. The presence of feedlots in the area complicates the problem.

Constant and continuing treatment is badly needed on all land. Problems needing attention include: dry land erosion--nearly 1,743,000 acres; wetness--61,600 acres; and local flooding--8,700 acres. Cooperative land treatment should be installed on 23 watersheds. Much of the activity could be accomplished concurrently with irrigation development to minimize surface erosion. Management of public lands should emphasize controlling livestock grazing and protecting the key winter deer range.

There are more than 1 million acres of potentially irrigable land in the subarea. However, the Bruneau River is not a likely source of water because of its relatively small available supply, deep entrenchment, and possible designation as a wild river; other local tributaries contribute only small amounts of usable runoff. More than 400,000 acres of lands on the Bruneau Plateau are less than 600 feet above the Snake River making it the most likely source of irrigation water. However, to irrigate any sizable acreage would require substantial storage either on the Snake River or at offstream sites on the plateau. Other alternatives include: continued expansion of direct river pumping to adjacent lands, exchange ground-water pumping from the Snake Plain Aquifer upstream, transbasin diversions from the Boise, Payette, and Salmon Rivers, a long canal from Milner Dam, and pumping local ground water.

An estimated 58,000 acres of new irrigation adjacent to the Snake River could be irrigated by direct pumping from the river (50,000 acres) and from local ground water (8,000 acres). The program should consider developing water



Here water is pumped from the Snake River to serve a large acreage (USBR).

supplies to irrigate an additional 340,000 acres. Ground water could be used for 58,000 acres; the remaining land could be developed by pumping from the Snake River into new offstream storage of some 500,000 acre-feet capacity. The new reservoirs could also help meet many of the recreation, fish, and wildlife needs of the subarea. If the above were developed without a substantial amount of new offstream storage, pumping from the Snake Plain Aquifer in Subregion 4 would be required in dry years to maintain water quality and fish flows. The plan includes 15,000 acre-feet of new storage on Succor Creek to supply supplemental irrigation water for 10,000 acres and provide flood control and recreation benefits.

Wildlife enhancement potential for the entire Bruneau area should be more precisely defined in order to avoid major conflicts with big game and sage grouse. With proper planning and zoning the prime wildlife area could be bypassed. In addition to the study being made to determine the recreation potential of the Bruneau River in Idaho, parts of the Snake River, all of the Jarbidge River, the Bruneau River in Nevada, and the Jarbidge Mountain area should be studied.

Single-purpose flood control storage does not appear feasible because of limited benefits and major conflict with environmental interests. Flood plain zoning, and other nonstructural measures, could be used to minimize flood losses.

Boise Subarea (Subregion 5)

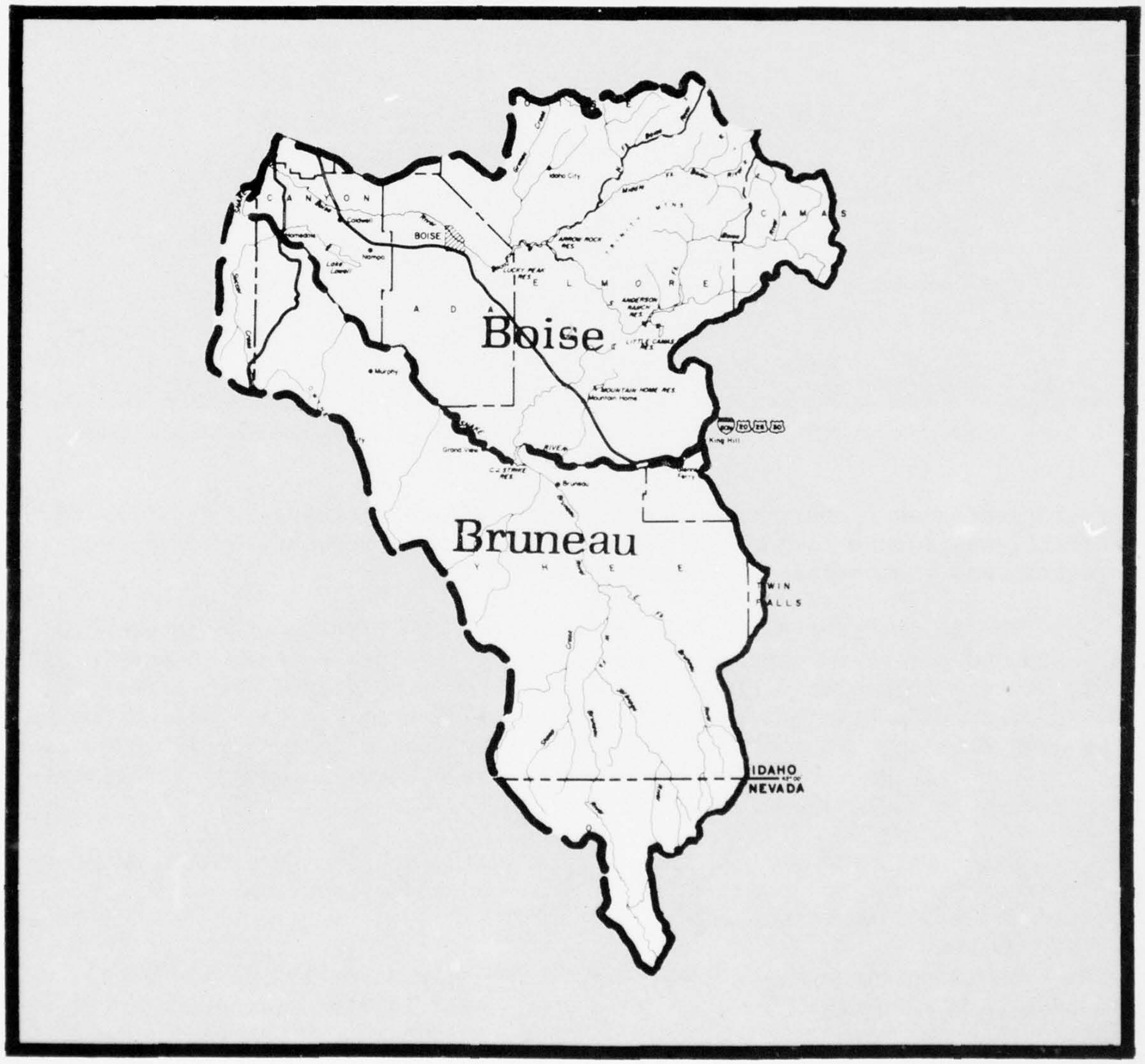
The Boise Subarea consists of the Boise River drainage plus the area south and east to the Snake River, including the Mountain Home Plateau. The northeast section of forested mountains provides considerable recreation and water. The area downstream from the city of Boise contains a highly developed irrigated agriculture economy with only limited potential for further expansion. The desert area between Boise and the Snake River to the southeast has lands suitable for irrigation.

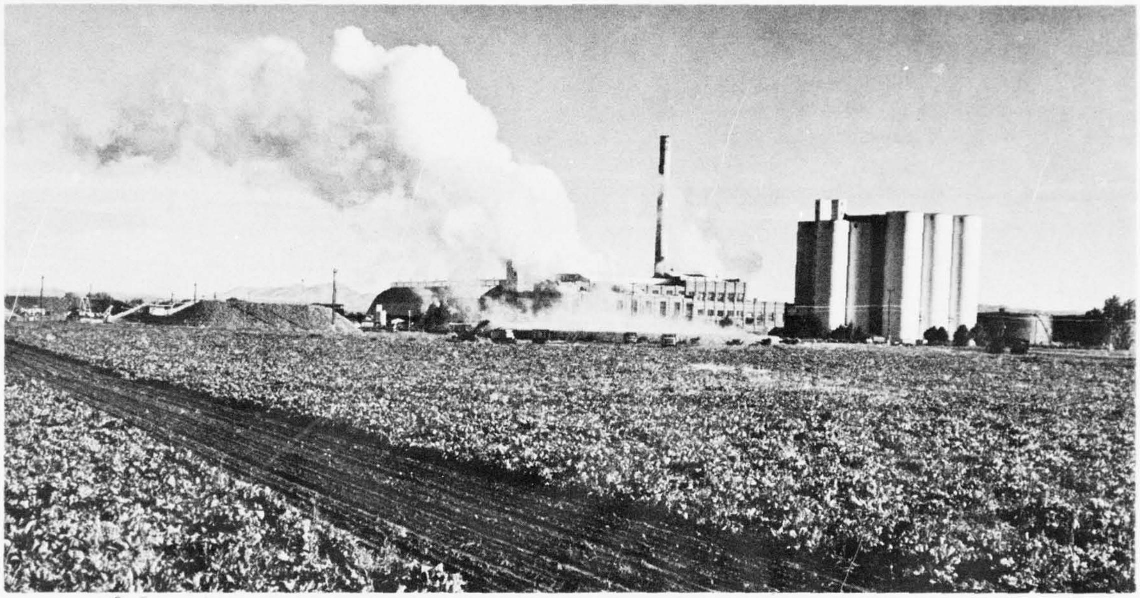
The natural flow of the Boise River, supplemented by about a million acre-feet of storage in Anderson Ranch, Arrowrock, Lake Lowell, and Lucky Peak Reservoirs, supplies water to over a third of a million acres. These reservoirs also afford the Boise Valley significant flood protection. The free-flowing stream segments and the reservoirs provide a favorable mix of water-oriented recreation opportunities.

A serious water quality problem exists below Boise where, at times, streamflow consists almost entirely of irrigation return flows and municipal waste water. Feedlot drainage also contributes turbidity, dissolved solids, and bacterial contamination. Flow stoppages every 2 or 3 years for maintenance work on the Lucky Peak Dam outlet and irrigation diversions have added to the problems. Although improved treatment has decreased the adverse effects of these wastes on the river, game fish production, recreational opportunities, and esthetic values have been reduced. Minimum flow requirements for water quality in the Boise River at Boise, currently estimated at 113 cfs, were projected to increase to 330 cfs by 2020, even with the adopted levels of treatment.

Although reservoirs substantially control the Boise River, it still causes some flood damage in the lower valley. In addition, four side-hill tributaries on the north side of Boise cause extensive flood damage to residential properties. A green belt and some offset levees from Lucky Peak Dam to the mouth of the Boise could minimize that flood damage problem, provide much needed recreation and wildlife areas, and eliminate cattle feedlot and septic tank effluents from the river. Complete control of the Boise River could be accomplished by providing 600,000 acre-feet of storage on the Middle Fork at the Twin Springs site. Although this amount of storage would reduce flooding, provide flows for water quality and power, and create a 14,000-acre lake, it would inundate 21 miles of stream with high recreation potential and flood 4,500 acres of big game winter range. Single-purpose flood control detention dams and zoning are needed on Cottonwood Creek and Stuart, Crane, and Hulls Gulches.

There are major erosion problems involving over 1,558,000 acres. In addition, 55,700 acres have wetness problems and 8,400 acres of upstream lands are subjected to flooding. Cooperative land treatment should be applied on 18 watersheds with special emphasis given to controlling erosion and im-


BOISE
Boise
Bruneau
IDAHO
NEVADA



Southwestern Idaho produces nearly a third of the sugar beets grown in the Columbia-North Pacific Region (USBR).

proving water and land management practices and water supply. Measures for forest lands should include establishment of better vegetative cover, control erosion, and reduce stream sedimentation.

The Boise River Basin and the Mountain Home Plateau have about 90,000 and 500,000 acres, respectively of potentially irrigable land. About 70,000 acres in the Boise Basin along Willow Creek could be served from either the Boise or Payette Rivers. The Payette River is the more likely source due to the high existing use of the Boise River. Irrigation water for 197,000 acres of the Mountain Home Plateau is proposed through water exchange arrangements using Payette, Boise, and Snake Rivers.

Municipal, industrial, and rural-domestic water supply needs could be met through expansion of existing systems. Adequate treatment should be provided for all municipal and industrial wastes.

The retention of the scenic mountainous area for its environmental and recreational values was of prime concern. Water related recreation needs in the vicinity of population centers is also recognized. Measures should be taken to preserve prime recreation and wildlife areas and further study of the entire Boise River system should be conducted to determine which free-flowing reaches should be maintained for their value to recreation, fish, and wildlife, and where major water storage developments should be made. Hunting and fishing access should be secured and roads built to selected areas. Big game winter

range should be improved and protected, and specific endeavors similar to the establishment of Kokanee salmon in Anderson Ranch Reservoir should be undertaken.

Payette Subarea (Subregion 5)

A wooded, mountainous region, the Payette drainage basin is dissected by large rivers flowing in long, narrow valleys. Small glacial lakes dot high mountain meadows while several manmade lakes cover significant portions of the lower elevation bottom lands. Waters of the Payette are generally clear, cool, and of high quality. From Black Canyon Reservoir upstream, the North, Middle, and South Forks of the Payette River provide about 150 miles of prime recreation stream.

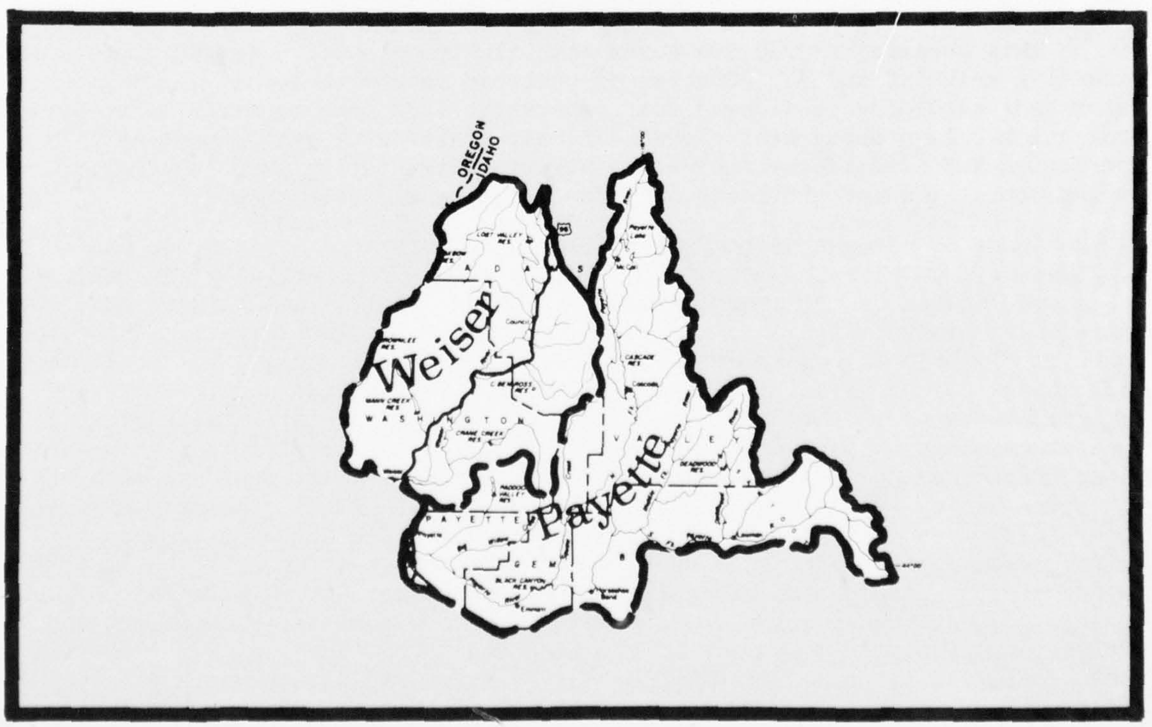
Flood damages are confined primarily to the lower Payette Valley below Black Canyon Dam, but high runoff also floods the Montour Valley. Zoning is needed in the vicinity of Payette, Emmett, and Horseshoe Bend, and a study should be made of the lower river to determine the feasibility of a green belt with levees and channelization.

Water supplies for municipal and industrial, as well as rural-domestic use, would come from ground water. New or improved waste treatment facilities should be provided at Emmett, McCall, Donnelly, and Cascade.

This subarea has 950,000 acres with erosion problems, 18,400 acres with excessive wetness, and 32,300 acres of upstream land with local flooding. Nine watersheds should be considered for cooperative land treatment and watershed protection. Land management should deal especially with enhancement of recreation and wildlife by minimizing stream sedimentation from logging and mining operations and providing feed for wildlife and livestock.

About 80 percent of the 150,000 acres of irrigated land in the basin is adequately supplied. Most of the 130,000 acres of potentially irrigable lands are located on tributary streams where land quality and climate severely limit their productivity. To assist in meeting projected irrigation needs it would be possible to construct 2.4 million acre-feet of storage on the South Fork at the Garden Valley site. This storage could provide sufficient water to irrigate lands in the Payette drainage and on the Mountain Home Plateau on a water exchange basis (see Boise Subarea). It could also afford significant flood control along the Payette River. Hydroelectric power could be generated at Garden Valley and at several locations on Scriver Creek. The Scriver Creek power facilities could be used to carry North Fork Payette water to Garden Valley Reservoir. Other power development from reregulation of releases and pumped storage should also be explored. An additional 80,000 acre-feet of storage could be constructed on Gold Fork for flood control, recreation, and irrigation. About 10,000 acres of new land and 28,000 acres of water-short lands could receive full irrigation supplies from Gold Fork and other existing water sources in the upper Payette. Some 67,000 acres of new land on the

Irrigated orchards in the lower Payette Valley (USBR).



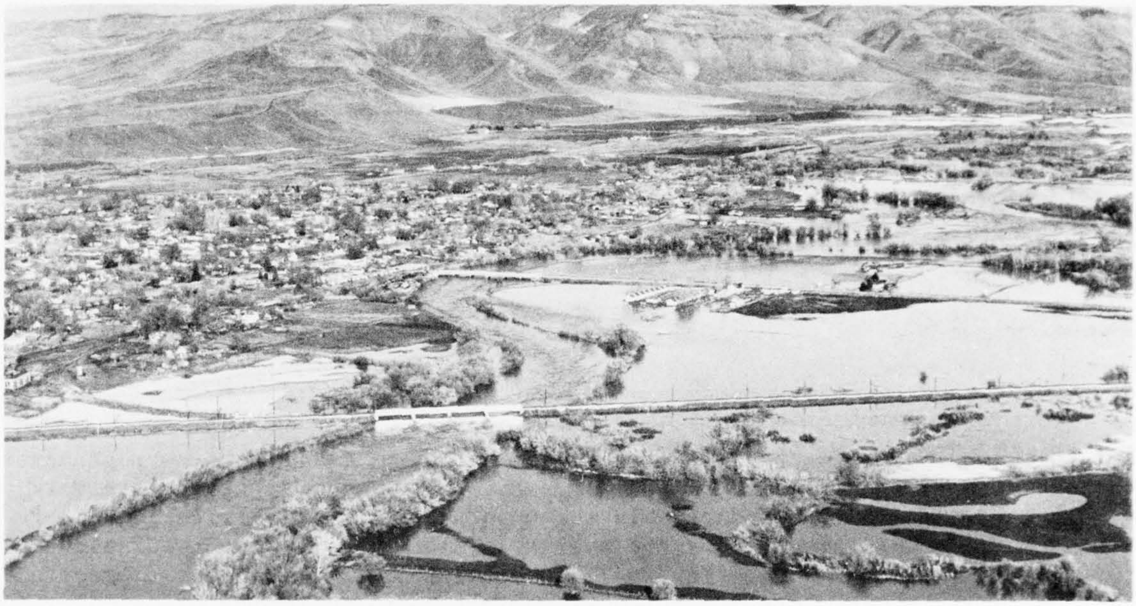
Willow Slopes areas in the lower basin could be irrigated primarily from existing reservoirs.

Certain adverse environmental effects would result from construction of additional storage or channelization and levees. Garden Valley Reservoir would inundate about 35 miles of forested stream and critical big game habitat. Considerable habitat would be lost with channelization and levee works along the Payette River. These effects could be minimized by the use of offset levees and provisions for a green belt for wildlife habitat between the streambank and the levees. However, development of storage facilities and the use of Payette River water is the key to meeting projected needs in southern Idaho.

Weiser Subarea (Subregion 5)

The Weiser Basin is a rolling upland and mountainous area having narrow valleys with strips of farmland near streams. The wooded mountains are very scenic and wildlife is abundant. In the upper basin, large irrigation diversions are made when streamflows are available; the return flows are reused for irrigation downstream. Existing small reservoirs are insufficient to meet all the water supply and flood control requirements, and quality of the river water is low. Excessive turbidity during high runoff periods and high temperatures during low flow periods preclude a significant fishery. Inadequate septic tank installations at Cambridge contribute to water quality problems in the Weiser River.

Most flood damages occur in and near Council, Cambridge, Midvale, and Weiser; Weiser is the largest problem area. Enlargement of Lost Valley Reservoir could contribute to the control of high flows; however, it appears that channelization and levees are the most feasible structural measures for significantly reducing damages on the lower 13 miles of the river and at Cambridge and Midvale. To eliminate the adverse effects of channelization and levee works, setback levees could be used. Flood plain zoning should be implemented immediately to assist in keeping future damages at a minimum. A green belt along the lower 13 miles of the Weiser River and through all upstream towns could offer recreational opportunities.



Flooding near Weiser, Idaho, February 1957 (USCE).

Studies are needed to determine instream flows necessary to sustain satisfactory water quality for fish and wildlife habitat. Water quality measures should include treatment of municipal and industrial pollutants, and watershed management to control discharges into the streams. A significant portion of the upper watershed area needs land treatment and watershed protection measures. There are over 821,700 acres with erosion problems, 16,800 acres with excessive wetness, and 15,000 acres of upstream land with local flooding; nine watersheds need cooperative treatment. Major emphasis would be on water conservation, erosion and sediment control, and streambank stabilization and channel modification. Regulating logging and mining activities would reduce stream sedimentation and pollution.

The bulk of the remaining 100,000 acres of potentially irrigable land is located on plateaus above the river where development would require extensive diversions or pump lifts. Several storage possibilities exist in the basin, but the most promising are enlargement of the existing Lost Valley Dam and new offstream storage at the Monday Gulch site or at the Tamarack site on Weiser River. The Lost Valley enlargment or storage at the Tamarack Site could supply water to lands in the vicinity of Council; the Monday Gulch Site to lands around Cambridge and Midvale. An alternative to both of these new sites would be a 250,000 acre-foot reservoir on the Weiser River near Goodrich. However, this site would have high right-of-way and relocation costs and could be detrimental to streamside recreation. A total of about 3,000 acre-feet of storage on Camp Creek and a 3,400 acre-foot facility on Sage

Creek could be used primarily to supplement presently irrigated water-short lands. All of this new storage would serve recreation and flood control as well as irrigation.

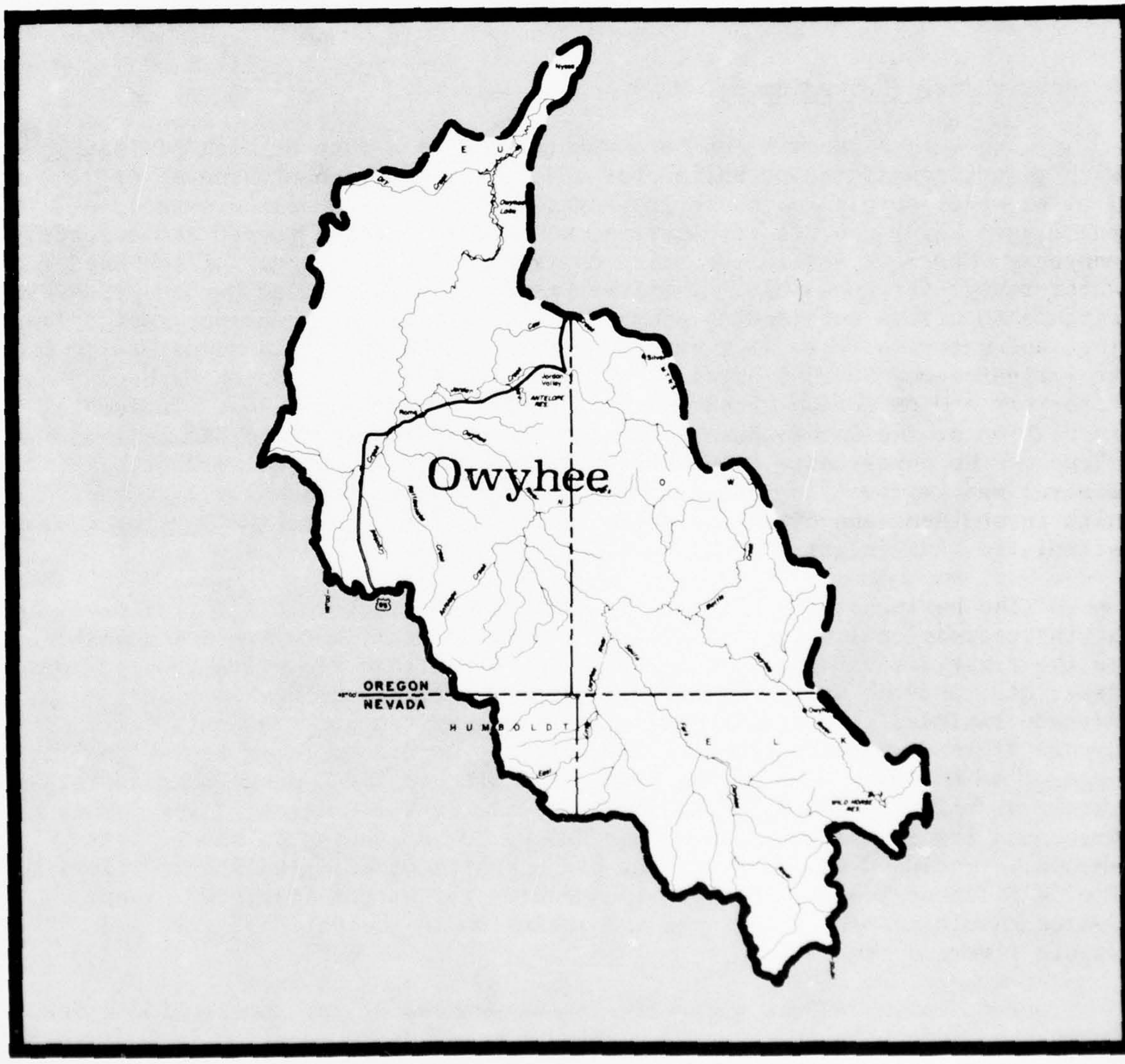
Either ground water or convenient surface supplies would provide future municipal, industrial, and rural-domestic water needs.

Owyhee Subarea (Subregion 5)

The Owyhee Subarea can be characterized as a rugged, high plateau with relatively little potential for additional development because of limited water supply and short growing season. It is deeply dissected by the Owyhee River and its tributaries, which flow through rugged and colorful canyons. Numerous small reservoirs on tributaries store much of the head-water runoff for local use. The lower river is regulated at Owyhee Reservoir which also offers outstanding opportunities for fishing, hunting, rock collecting, and water sports. With existing storage, the runoff is almost fully used to irrigate some 360,000 acres. Most flood damage occurs below Owyhee Reservoir and on Jordan Creek in the vicinity of Jordan Valley. Incidental regulation at the Owyhee Reservoir has prevented considerable damage, but there may be opportunity to optimize the operation to better serve flood control and improve flows downstream. The water is seasonally warm and high in sediment and dissolved solids; high nutrient concentrations have stimulated heavy algal growths.

The basin has 358 miles on several streams that were identified as having recreational value. They are: Owyhee River from Owyhee Dam downstream to the first diversion dam; from Lake Owyhee upstream 213 miles to Wild Horse Reservoir; and the North, Middle, and South Forks of the Owyhee River. Already included in Oregon's Scenic Waterways System are the South Fork Owyhee River downstream from the Oregon-Idaho border to Three Forks, and the segment of the main stem Owyhee River from Crooked Creek downstream approximately 45 miles to the mouth of Birch Creek. Over 290 miles of the Owyhee River and its forks in Oregon and Nevada would be studied to see if they should be included in a national or state system of wild and scenic rivers. The 70 miles of the Owyhee River included in the Oregon Scenic Waterways System should also be considered for inclusion in the national wild and scenic rivers system.

This basin has the greatest erosion problem of any in the Middle Snake Subregion, encompassing nearly 3,058,000 acres. Other problems include wetness on 47,500 acres and local flooding on 8,850 acres. There are 15 watersheds that would receive cooperative treatment. Measures would be included to reduce wind and water erosion, improve irrigation water management practices, provide opportunities for waterfowl enhancement, and improve water quality. Flow augmentation for fish and water quality control would be a key element of the program for those reaches of streams below storage in Oregon.


Owyhee
OREGON
NEVADA
HUMBOLDT
ANTELOPE RES.
WILD HORSE RES.

More than 162,400 acres of irrigated land in this basin have inadequate water supplies, and opportunities for developing supplemental water are very limited. On Jordan Creek near the Idaho-Oregon border, a 10,000-acre parcel of land has an adequate water supply during the early part of the season but needs a late-season supply. Storage of 65,000 to 100,000 acre-feet on Jordan Creek would serve the functions of flood control, recreation, and supplemental irrigation. Fishery benefits are not possible because of excessive mercury in the drainage. About 1,270 acres of big game and upland game habitat would be inundated.

About 53,000 acres, west of the existing Owyhee Project and south of Vale, would be served by pumping from the Snake River and from ground water. By pumping into offstream storage from below the mouth of the Boise River, advantage would be taken of the increased flows in the Snake at that point. Water for 17,000 acres in the Lockett Gulch area west of Nyssa would be pumped from the Snake River and stored in a 42,000 acre-foot offstream site in the same area; local ground water would be used to irrigate 26,000 acres at various locations throughout the basin in Oregon.

Retention of environmental values is of prime consideration. Acquisition of 30,000 acres in the Owyhee Desert and flood plain should be considered for the enhancement of upland game, waterfowl, and fur-bearing animals.

All existing water rights, including those of the Duck Valley Indian Reservation, must be considered in planning for this basin.

Malheur Subarea (Subregion 5)

The Malheur Subarea is a high, rolling upland area with well developed, irrigated bottom lands. Four existing reservoirs provide significant regulation of streamflows and virtually all surface flows are presently being used. In most years these reservoirs furnish a full irrigation water supply to more than 130,000 acres, provide recreational opportunities, and, along with a channel and levee project at Vale, significantly reduce flood damages. The principal flood problem areas are along the Malheur River downstream from Harper and along Upper Bully Creeks near Westfall. These areas are now used for agriculture but could be developed into homesites if zoning and other constraints are not imposed. Flood plain zoning and other nonstructural management would be used along the Malheur River in the vicinity of Vale and Ontario to prevent encroachment on the flood plains.

Many concentrated and continuing land treatment practices are necessary for a large area with erosion problems (2,040,000 acres). There are also 11,100 acres with wetness problems and 9,500 acres of upstream lands subject to local flooding. Cooperative treatment is needed on 12 watersheds. Management activities would be associated with reducing wind and water erosion, better management of grazing lands, and additional water supplies. Programs

for the management of public lands would shift to the enhancement of lands for wildlife. Better water use is planned for some 60,000 irrigated acres which presently experience late season water shortages.

The quality of Malheur River water is degraded by irrigation return flows, food processing wastes, and annual floods. The stream is seasonally warm, high in sediment and dissolved solids, and burdened with heavy aquatic growths. The waste problem in the Ontario area would be dealt with by installing adequate treatment facilities. Other remedial measures would be used to combat isolated instances of waste loading.

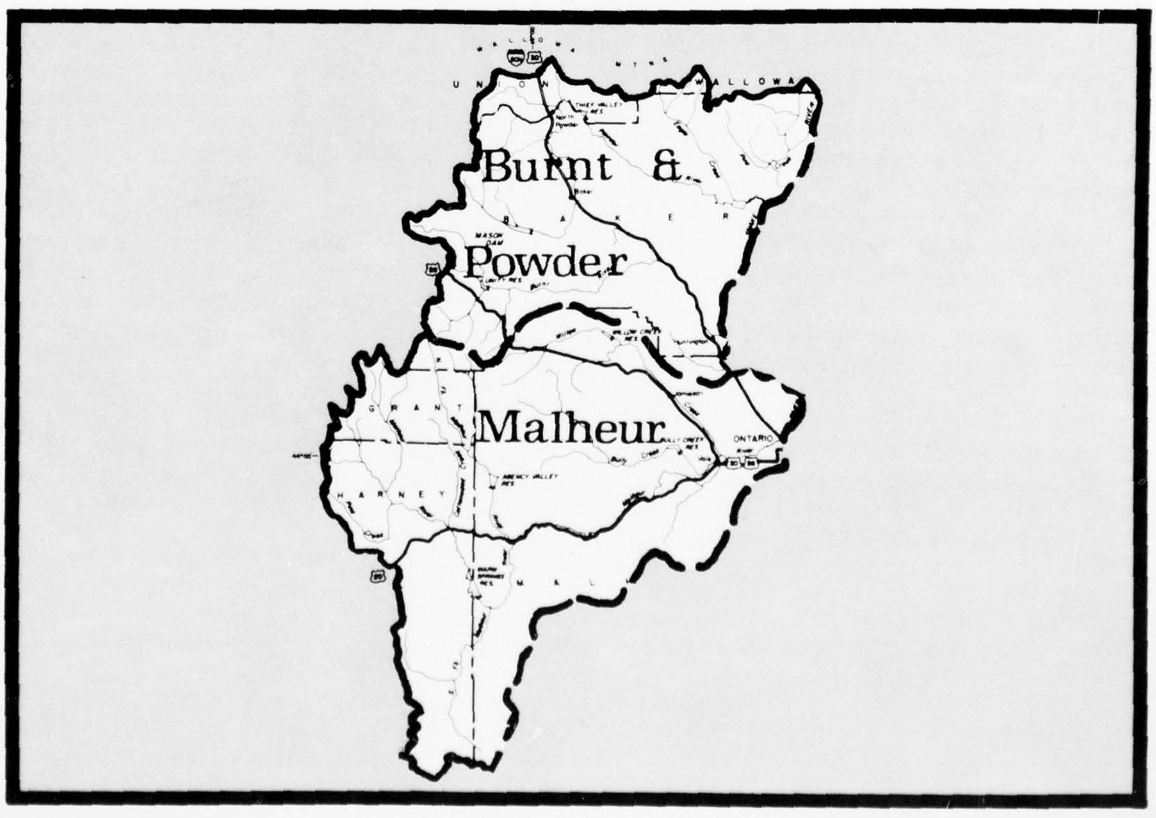
Any substantial development of the half-million acres of potentially irrigable land must be accomplished with water from outside sources. As much of the potentially irrigable land lies in the vicinity of the Snake River, a readily available source the plan includes a considerable amount of irrigation development. Although some conflict exists with big game and upland game in this area, conflicts can be minimized by adequate consideration of prime wildlife habitat in formulating irrigation plans. An area of 133,000 acres, northwest of Ontario between the Snake River and Willow Creek, could be developed from the Snake River with pump lifts of less than 400 feet. Water would either be pumped into offstream storage or used directly from Brownlee Reservoir to irrigate 80,000 acres in the vicinity of the Snake River; 20,000 acres would be developed from local ground water. An additional 33,000 acres could be served by pumping from the Snake River into a 57,000 acre-foot reservoir in the Cow Hollow area. Means to furnish supplemental water for 60,000 acres are not identified in the plan. Additionally, long-range planning should provide for using Snake River water on presently irrigated, lower elevation lands in exchange for using their water supply on higher elevation lands.

Burnt and Powder Subarea (Subregion 5)

The Burnt and Powder River drainages lie entirely within Oregon and drain mostly semiarid areas. Characteristically, the basins are composed of rolling sage-covered hills and narrow valleys with an occasional expansion into broader valleys. In marked contrast are the high rugged mountains that contain the headwaters of the Powder and Burnt River tributaries.

Irrigated lands, of which about 70 percent have substantial water shortages, are located in several valleys along the Powder and Burnt Rivers. Supplemental water for these lands and development of any new irrigation would require additional storage, pumping from the Snake River, more efficient use of present supplies or use of ground water. Because of erratic flows, irrigated lands along East Pine Creek, Wolf Creek, and the North Powder River often have an overabundant water supply in the spring but are short of water by midsummer. The serious flooding and the lack of late season water would be reduced with the construction of storage facilities on each of these streams.

A crop of sugar beets in the area of Ontario, Oregon (USBR).



An estimated 10,000 acres of dry land and 20,000 acres of water-short lands would be benefited during critical years if 50,000 acre-feet of storage were available. An estimated 15,000 acres of new land along the Powder River could be developed with ground-water pumping.

Construction of two storage facilities with total capacity of about 26,000 acre-feet is planned on the Burnt River, one near Dark Canyon (12,000 acre-feet), the other at the Hardman site (14,000 acre-feet). These reservoirs would be used mainly for irrigation, but would provide some flood control and recreation as well. These reservoirs, along with direct diversion from the Snake River, would furnish 19,000 acres of dry land with a full irrigation water supply and supplement supplies to 63,000 acres of water-short land. Studies would be needed to determine the effects of these developments on wildlife and to provide remedial measures.

Although existing reservoirs are effective in reducing flood damages along the Burnt and Powder Rivers, remaining damages are expected to more than double by 2020 if no other measures are implemented. A channel project at Baker would provide effective flood control, and zoning would prevent further development in the flood plain.

This subarea has 831,900 acres with erosion problems, 28,700 acres with excessive wetness, and 10,000 acres of upstream land with local flooding. Nine watersheds would have cooperative land treatment with emphasis on water and land conservation measures. Other programs would involve reducing erosion and providing drainage for much of the presently irrigated lands. Vegetative cover would be improved by range renovation and better control of livestock grazing.

The plan for water quality improvement includes installation of necessary facilities to adequately treat all municipal and industrial wastes, implementation of methods to reduce or prevent significant concentrations of animal wastes from entering streams, and insuring the adequacy of rural-domestic and recreation waste disposal facilities.

Few identifiable conflicts were encountered in selecting a plan. With a limited water supply and few good reservoir sites, it was not practical to consider large-scale storage. Although some big game and upland game habitat would be destroyed, measures would be taken to minimize losses by bypassing key habitat areas and improving habitat in other areas.

Upper Salmon Subarea (Subregion 6)

The Salmon River down to and including the North Fork and the Lemhi and Pahsimeroi Rivers comprise this subarea; picturesque mountains rugged landscape, and scenic rivers are the dominant features. Except for cattle ranches and a few small towns, this basin is largely uninhabited. Salmon, the largest town, is an important headquarters for back-country guides, river men, and outfitters. The Salmon River and its tributaries support a major portion of the last remaining runs of salmon and steelhead in Idaho.

Minor flood damages occur near Salmon, Challis, and Shoup, and along the Lemhi River. Channel improvement and levees would alleviate the flood problems at Challis; either upstream storage or channel improvement and levees would protect Salmon. Flood plain zoning should be considered at both locations.

A total of 135,000 acres are irrigated, of which some 56,000 acres have late season water shortages. An additional 73,000 acre-feet would be required to provide full supplies.

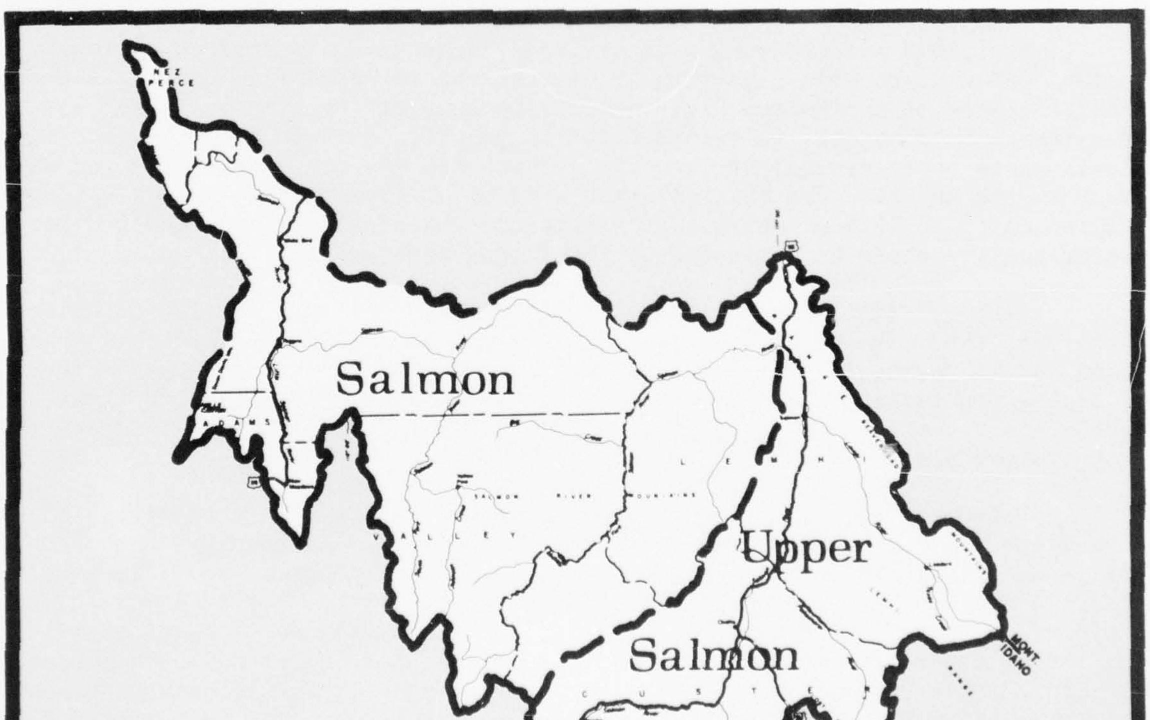
Municipal and industrial water requirements are expected to be small. Salmon and Challis will have trouble meeting future needs from present sources and will need to use Salmon River water with complete treatment. Other communities should be able to expand existing supplies to meet their needs. The small waste loads discharged into the streams now are not expected to increase much in the future. The Williams Lake Area is an exception and shows evidence of increased pollution. With this exception, the minimum flows required for water quality could be satisfied by the flows required for fish.

Although the lands in this basin do not have serious erosion or other problems, there are 440,000 acres (mostly rangeland) that have moderate erosion, 24,000 acres of cropland with wetness problems, and 7,000 acres with flooding problems; about 137,000 acres of cropland need special land treatment. To maintain the land in a suitable condition, 14 watershed areas will require cooperative planning and treatment.

The Upper Salmon River has a high recreation use, due largely to the excellent hunting and fishing; this use is expected to increase in the future. It is accessible to tourists and very desirable for summer homes. The problem is to preserve this prime recreation area and still allow the resident agricultural and forestry economy to exist and prosper. In addition, possibilities are being considered to transfer water from the Upper Salmon Basin to the Snake, Payette, Boise, Big Wood, or Big Lost River drainages. The relatively modest streamflows in the upper Salmon River present a great problem in making decisions between fish and wildlife and other development uses.

A major feature of the program would be studies for the preservation of fish and wildlife, major recreation and fishing streams, and scenic areas. These would be followed by programs dealing primarily with managing the

Hunting for big game in the upper Salmon subarea has much appeal to the sportsman (Idaho Fish and Game Dept.).



area's outstanding environmental and esthetic qualities. Activities could include purchasing prime big game winter range and enhancing its carrying capacity, enhancement of anadromous fish runs through construction of additional artificial production facilities, controlling soil erosion, and stabilizing streambanks.

The studies indicate a possibility of constructing 10,600 acre-feet of storage on Challis Creek to irrigate 140 acres of new land, and to provide 2,600 acres of water-short land with a full supply. This facility could also provide some flood control, recreation, and minimum flows for fishery enhancement. Development of nearly 58,000 acre-feet of ground water to irrigate 3,500 acres of new land and supplement supplies for 38,600 water-short acres could also be carried out.

Four small storage projects could provide about 22,000 acre-feet of storage for a limited amount of flood control, to irrigate about 1,300 acres of new land, and to firm up supplies on 14,800 water-short acres. In addition, water would be available to supplement late season streamflow. Storage could be built on Hawley, Double Springs, Bear Valley, and Agency Creeks. Their locations would not materially affect anadromous fish runs or big game winter habitat.

Salmon Subarea (Subregion 6)

The Salmon River drainage below the North Fork and Idaho tributaries of the Snake River from Hells Canyon to the mouth of the Salmon, contain some of the region's most rugged landscape. Included are the Idaho and Salmon River Breaks Primitive Areas which are being studied as to their suitability for inclusion in the National Wilderness Preservation System. This virtually uninhabited and nearly inaccessible subarea has a major wildlife resource and the major Idaho fishery from salmon and steelhead, both of which require preservation. Some 90 miles of the Middle Fork Salmon River have been included in the national wild and scenic rivers system, and 212 miles of the Salmon River are under study for possible inclusion in this system. The Snake River below Hells Canyon Dam has been recommended for study. Another 296 miles of rivers are considered as important recreation rivers.

Flood damages are minor except at White Bird where channel improvements and levees along Whitebird Creek are needed.

The 5,000 acres of irrigated land all experience late season water shortages. An additional 6,500 acre-feet of diversions would be required to provide full water supply and could be provided from ground water. No new irrigation is anticipated.

Navigation needs are slight, but the Middle Fork is used intensively by float boats; the Salmon River is used by float boats and special power

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The middle Salmon River country

boats from below Salmon down to Riggins
river navigation on the Snake River par
Salmon River, requires that minimum flo
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There are opportunities for exte
Salmon and Snake Rivers. However, the
valuable. The conflicts and competitio
point out the need for complete and obj
is made of the water and related land r

The water quality is generally g
increasing recreational use, logging ac
feedlot activities, corrective measures
lakes and streams or in areas with a hi

This subarea is not subject to s
undisturbed forest. About 2,000 acres
about 48,000 acres of upstream land hav
of the cropland requires special land t
areas require cooperative planning and

The initial programs should cons
potential for future generations. No n

facilities, or significant amount of local protection projects would be considered. Existing emergency levees in the White Bird area should be raised and strengthened to reduce flood damages. Long-range activities should consist primarily of preserving and enhancing the recreational opportunities through control of developments (mining, logging, hydroelectric power, and irrigation) that could detract from the esthetic quality of the area.

Clearwater Subarea (Subregion 6)

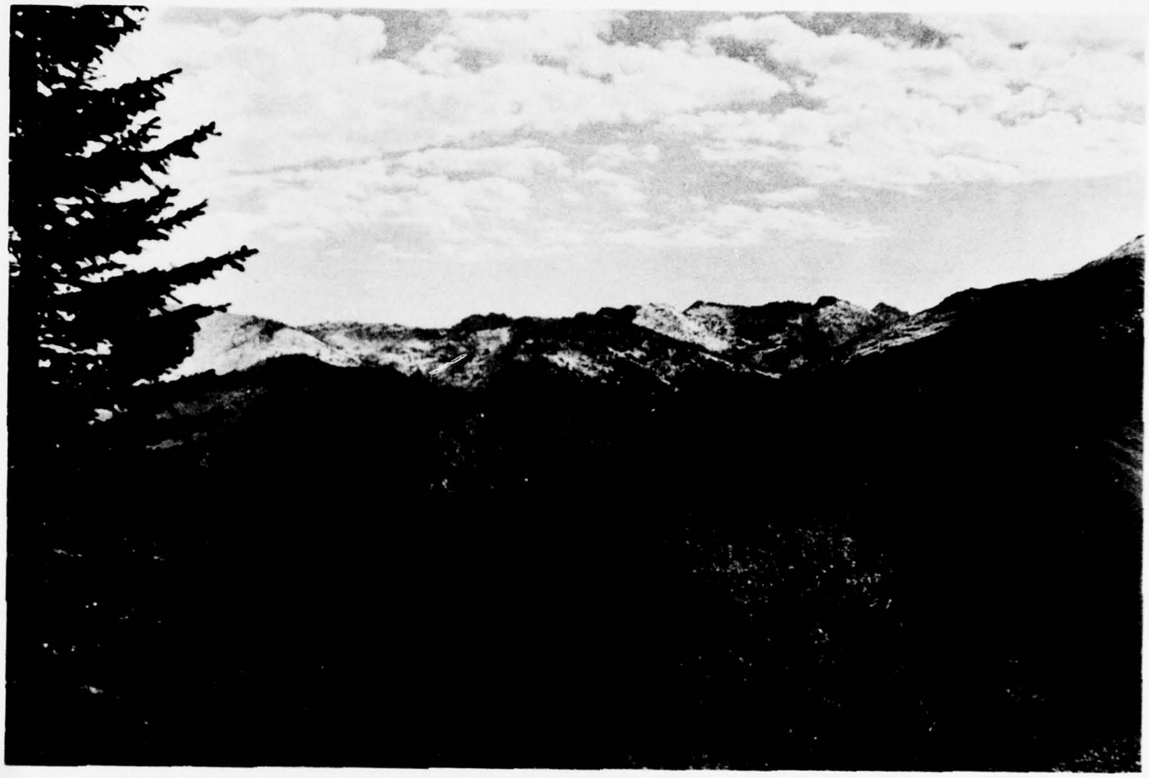
The Clearwater Basin is also sparsely populated and of great esthetic value. The rugged mountains, free-flowing streams, and excellent hunting and fishing make it an area of great recreational value. Part of the Selway-Bitterroot Wilderness is in the basin. Some 167 miles of the Middle Fork Clearwater, Lochsa, and Selway Rivers have been included in the national wild and scenic rivers system. The Clearwater Basin contains salmon and steelhead waters second only to the Salmon River.

Most of the existing development is located in the narrow lower valleys where it is vulnerable to flooding. The main river causes damages near Orofino, and tributaries cause flooding at Juliaetta, Stites, Kooskia, Kamiah, and Peck. Zoning is needed immediately at these towns. Control of flooding with storage would require 220,000 acre-feet of storage on the South Fork Clearwater River, as well as channel improvements and levees at the towns of Orofino, Peck, Kooskia, and Stites. The levees associated with Lower Granite Reservoir will largely eliminate Clearwater River flood damages in Lewiston.

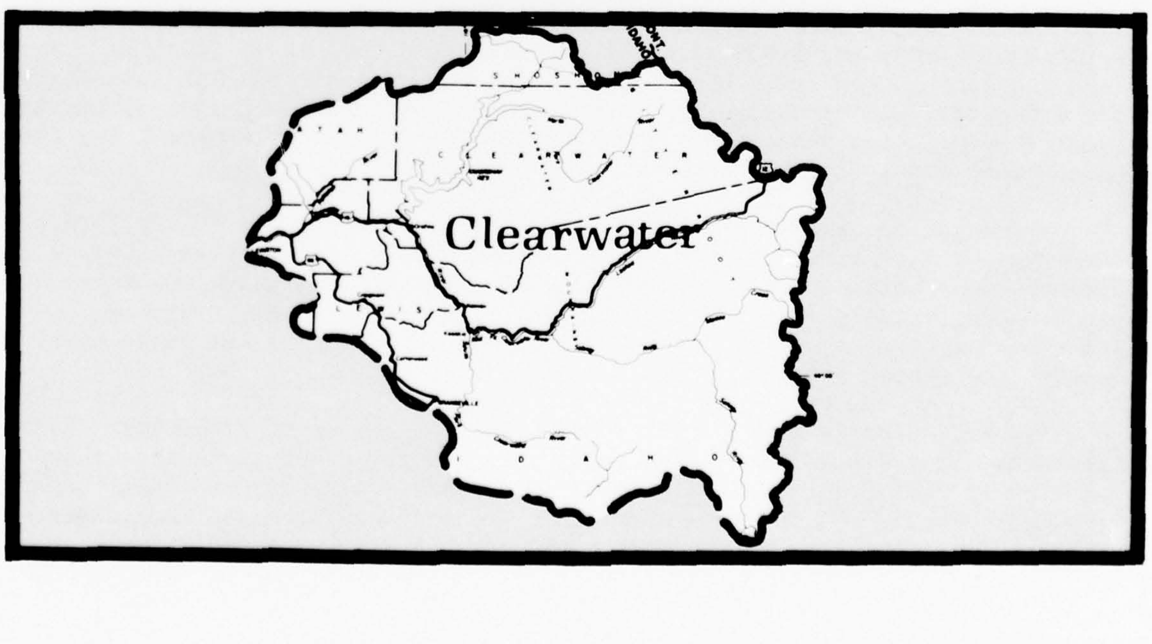
This basin has serious erosion and other land management problems, particularly on cropland in the lower portion, and from logging practices. Over 460,000 acres have erosion problems, an additional 12,000 acres have wetness problems, and 8,000 acres of upstream land have local flooding. There is a continuing need for protection and management of all the land to maintain its productivity, improve infiltration, and retard runoff. Twelve watersheds require cooperative planning and treatment. Prime big game winter range and upland game and waterfowl habitat could be enhanced.

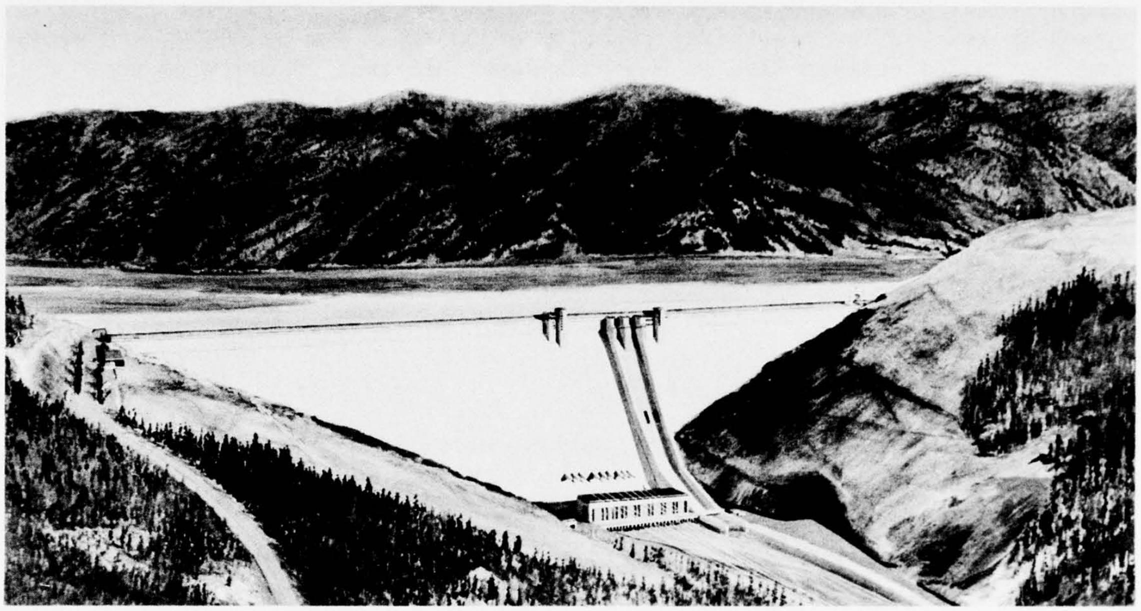
Irrigation development has been limited by the success of dry farming and high pump lifts required to raise water to agricultural areas. Only 1,500 acres are now being irrigated in the Clearwater Basin, of which 600 acres are experiencing water shortages. New irrigation would involve storage on selected tributaries of the Potlatch River and pumping from the Snake River because the ground-water supply is not reliable.

The Clearwater River, in general, has few sources of pollution. Waste treatment for the Lewiston service area and at a few other towns should be upgraded to meet requirements. Recreational wastes also need adequate sewage disposal systems, and feedlots need to be located away from surface waters. Proposed development along the shores of Dworshak Reservoir would require



This view of the Selway River country is indicative of the major part of this subarea (Idaho Fish and Game Dept.).





A rendering of Dworshak Dam on the North Fork Clearwater River in Idaho (USCE).

treatment facilities. No serious supply problems are foreseen in meeting the municipal and industrial water needs from existing sources.

There will be substantial power production from Dworshak Dam on the North Fork Clearwater River, and the basin also has other excellent reservoir sites for both hydropower production and flood control. However, study will be necessary to determine how much additional development can take place and still preserve the primitive areas and the free-flowing streams. As the demand for recreation activities continues to increase, there will need to be great expansion in facilities.

All water rights, including those of the Nez Perce Indian Reservation, must be considered in the planning for this subarea.

The framework program is largely oriented toward preservation of the natural environment. It includes studies of those free-flowing streams identified as having wild river potential, and limits additional works largely to those areas currently in some state of development. Incidental flood control, as well as some water-based recreation, could result from construction of small irrigation reservoirs.

The early action program relative to recreation, wildlife, and fisheries should deal with identifying activities required to meet future needs. The streams to be studied include the Clearwater and its North, South, and Little

North Forks; Meadow and Kelley Creeks; and the Lochsa River. The program inclues increasing the generating capacity of Dworshak Dam by 660 MW and providing control of nongame fish in Dworshak Reservoir and 100 miles of the Clearwater River, as well as habitat improvement and artificial production facilities for fish. Additional land could be acquired for stream access and for development of recreation areas.

Construction of an 18,000 acre-foot storage facility on Big Bear Creek in combination with large-scale pumping from the Snake River could irrigate 10,000 acres of new land and supplement supplies to 600 acres that are water-short.

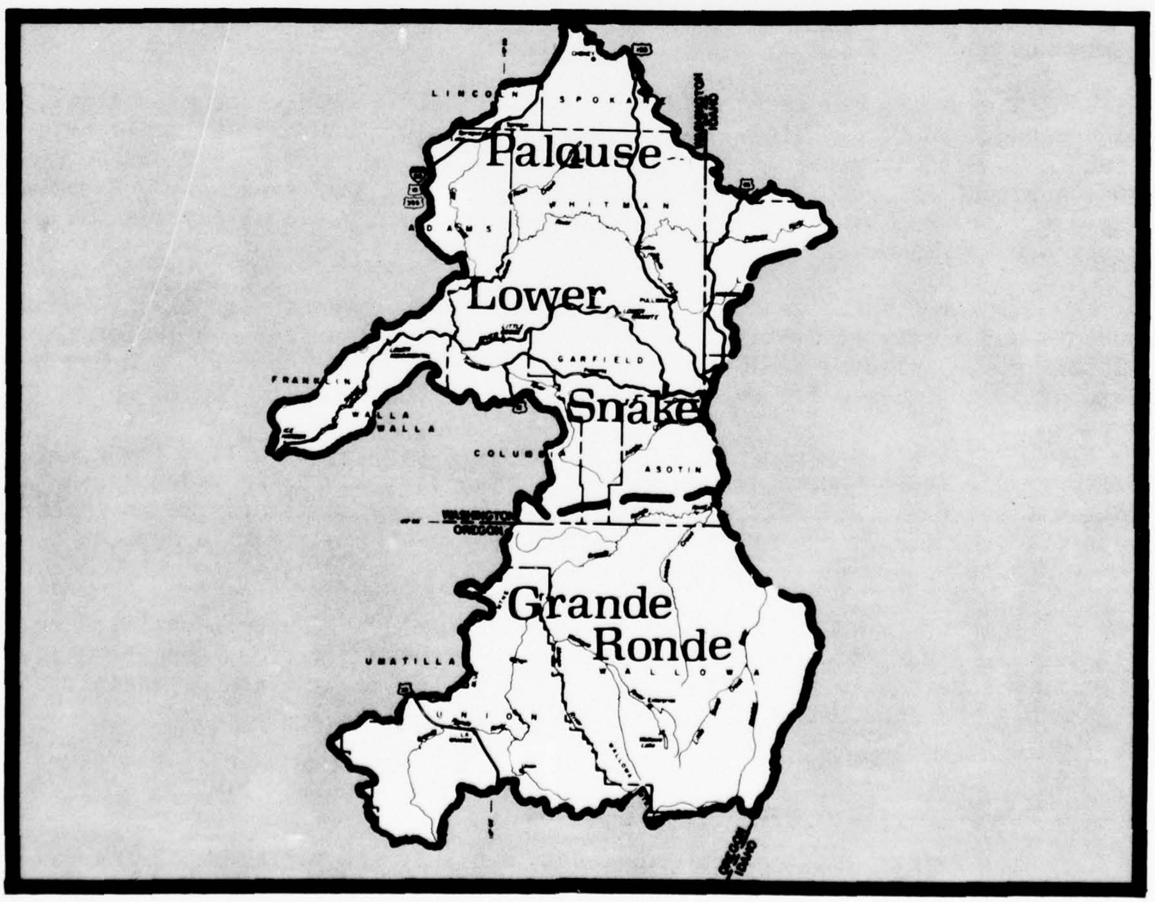
Grande Ronde Subarea (Subregion 6)

The Grande Ronde Subarea is characterized by marked contrasts in land forms. The high mountainous region, including the Eagle Cap Wilderness, is renowned for its scenic primitive beauty, big game hunting, and fishing; the rolling sage-covered hills and fertile valleys support a cattle-based economy. The area has prime big game winter habitat, supports significant populations of upland game and waterfowl, and provides excellent habitat for anadromous and resident fish. To the north and east is a range area where ancient rivers have cut deeply into the rock formations creating very rugged relief with outstanding scenic qualities. Agriculture and timber production are the primary industries, with recreation increasing in importance.

Severe flooding occurs in some places with most damages in the flat Grande Ronde Valley near LaGrande; bank erosion occurs along the middle and lower Wallowa River. Incidental floodwater storage is provided by Wallowa Lake and other minor reservoirs, but some additional storage is desired locally because of other uses that could be provided. Flood plain zoning is also needed at several locations.

Existing streamflows are used to irrigate 92,000 acres, but about 55,000 acres experience late season water shortages. A portion of the shortage could be offset by better water control and management, but storage would be needed to meet the needs of an additional 81,000 acres of new irrigation and to completely supplement existing supplies. A total of 13 storage facilities with an aggregate capacity of nearly one-half million acre-feet have been identified. This storage could also provide for fishery enhancement, water quality, flood control, and water-based recreation.

Much of the lower Snake subarea is rugged and mountainous; a good example is the lower Imnaha River drainage (USBR).



Two authorized projects, one on the Grande Ronde River and the other on Catherine Creek, would store 220,000 acre-feet. Five small reservoirs on the Lostine River, Bear Creek, Clark Creek, and in Rysdam Canyon would store a total of 50,000 acre-feet. The seven reservoirs would provide 4,500 acres of recreation water surface, and supply water for 34,800 acres of new irrigation and 18,500 acres of water-short land. Another 5,200 acres of new irrigation and 3,000 acres of supplemental irrigation would be served by ground water.

Six additional reservoirs would be required, providing 200,000 acre-feet of storage. They would furnish 2,600 acres of recreation water surface, supply minicipal and irrigation needs, control floods, enhance the fishery, and improve streamflows. In addition, 41,500 acres of dry land would be irrigated and supplemental water furnished to the remaining 33,500 acres of water-short land.

Flood control improvements, in addition to storage, would consist of 11 miles of levee and channel improvements on lower Willow Creek and on the Wallowa River near Wallowa and Enterprise. Flood plain zoning would be provided around LaGrande and other towns.

Nearly 450,000 acres of lands, divided nearly evenly among cropland, rangeland, and forest land, have erosion problems. About 20,000 acres of cropland have wetness problems, 24,000 acres of upstream lands have flooding problems, while around 300,000 acres of cropland need special land treatment. Coordinated multiple-purpose land and water utilization programs would be carried out on 10 upstream watersheds.

Improved waste treatment facilities are also needed for cities, industries, and mining activities, in conjunction with streamflow regulation to insure suitable water quality. Improved waste treatment facilities would be installed at Imbler, Island City, and Cove.

Preservation of the existing scenery and natural condition along with recommended improvements are needed to satisfy the increasing demands for recreation, fish, and wildlife needs. The Eagle Cap Wilderness is now being protected, but some 294 miles along six streams require study to determine if they should be preserved as free-flowing rivers.

Fish and wildlife enhancement programs would be better identified so that prime areas can be acquired and developed to meet recreational needs. Providing additional recreation facilities and the acquisition of associated lands will be undertaken at the storage facilities and lakes.

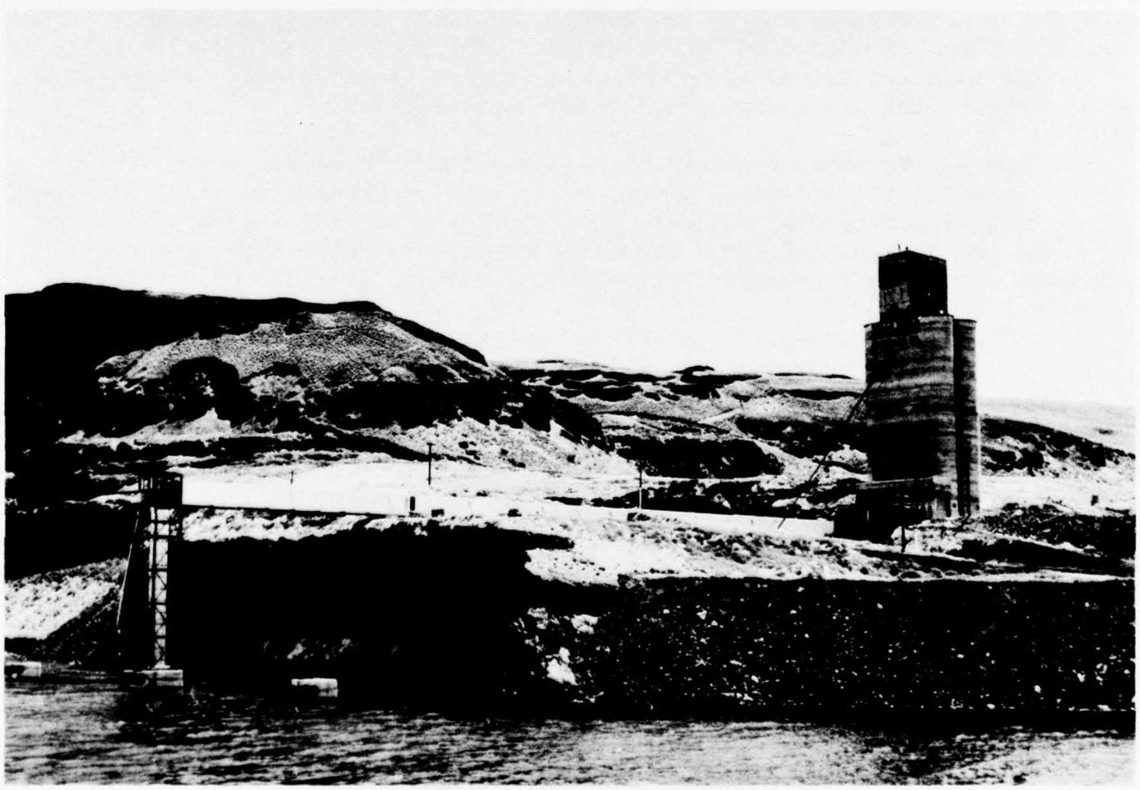
Palouse-Lower Snake Subarea (Subregion 6)

The Palouse-Lower Snake Subarea is a highly productive dryland wheat

area. There is considerable urban development, including Pullman, Washington, and Moscow, Idaho, with populations of 20,000 and 14,000 respectively.

The four run-of-the-river dams, Ice Harbor, Little Goose, Lower Monumental, and Lower Granite, will have an initial installed generating capacity of 1,485 megawatts and an ultimate capacity of 3,033 negawatts. When Lower Granite Dam is completed, slack water navigation will extend from the mouth of the Snake River through the subarea to Lewiston. This will result in considerable expansion in port and recreation facilities.

Flooding has been a problem throughout the Asotin Creek Basin, particularly around the town of Asotin; in the Palouse Basin at Pullman and Colfax; and in the Tucannon Basin, particularly in a narrow 40-mile reach in the vicinity of Starbuck. Bank erosion is a problem throughout the subarea. Flood plain zoning, flood proofing, and watershed treatment are all needed along with local protection works and/or channel improvement at Asotin, Starbuck, Albion, Moscow, and Pullman. Storage would be effective in several areas, but it is generally too expensive or has local opposition.



Grain loading terminal on Ice Harbor Pool (USCE).

At Moscow and Pullman, where ground-water tables have been dropping, there is an immediate need for additional municipal and industrial water. This could be provided from surface supplies but would require pumping some distance and probably more extensive treatment for quality. Other communities are expected to have adequate ground-water supplies.

Treatment of wastes at Moscow and Pullman needs to be upgraded; flow augmentation is required in Paradise Creek at Moscow, in South Fork Palouse River at Pullman, and in the Palouse River at Colfax. The heavy waste loads from pulp and paper mills at Lewiston and from other municipalities and food processing plants have significantly polluted the lower Snake River. An additional serious problem in the lower Snake River is that of nitrogen gas supersaturation, apparently resulting from air entrainment at dam spillways. Work is underway to minimize the supersaturated condition.

Erosion is a significant source of pollution in this subarea, which has the highest sediment yield in the region. The Tucannon and Palouse Rivers, in particular, carry heavy sediment loads during the winter and early spring runoff. Serious erosion problems occur on some 1.3 million acres of mostly dry cropland. Other land management problems include 45,000 cropland acres with wetness problems, and 91,000 acres with local flooding problems. Cooperative treatment is needed on 23 watersheds. The program would deal heavily in water and land management to reduce soil erosion, particularly in connection with construction of storage and irrigation facilities.

One of the major problems in planning for this subarea involves an Idaho law prohibiting storage of water in Idaho for use in Washington, except for municipal purposes at Pullman. Because the potential storage sites are in Idaho and most of the lands needing water are in Washington, the existing law precludes significant irrigation in the Palouse drainage unless amended.

Only 32,000 acres are presently irrigated in this area. Under the plan, water would be provided for some 388,000 acres of new irrigation and for 10,500 acres of water-short land. This would require an additional diversion of 1.4 million acre-feet and deplete supplies by 920,000 acre-feet. Although some ground water is available, the bulk of the additional irrigation water supply would come from surface sources. Available alternatives include pumping from the Snake River, storage on the Palouse River and its tributaries, diversions from the Spokane or Columbia Rivers, storage on the Tucannon River or its tributaries, and storage on some minor Snake River tributaries. All of these sources would have to be used to some extent. The plan includes 49 small storage facilities with a combined capacity of 476,000 acre-feet. They would provide recreation, irrigation water, flood control, and reduce the level of sediment load that pollutes the streams.

The construction and management activities would also furnish additional water-based recreation, provide the means to establish a fishery on many of the streams and habitat for upland game and waterfowl, and control of flooding.

AREA C
MID COLUMBIA RIVER, OREGON CLOSED BASINS, & COASTAL AREA, SUBREGIONS 7, 9, 10S, & 12

The Area and Its Needs

This area covers 76,850 square miles and embraces all of Oregon except the Klamath, Goose Lake, Snake, and Clatskanie drainages. It also includes that portion of Washington drained by the Klickitat, White Salmon, and Walla Walla Rivers which are tributaries of the Columbia River. The area is shown by subregions on figure 23.

The population in 1970 was 2,021,000. About 70 percent resided in the Willamette Subregion where the three largest cities, Portland, Eugene, and Salem, are located. Most workers are employed in producing, harvesting, or processing forest and agricultural products or providing goods and services. The economy is still resource oriented, but there is a growing trend toward service and "footloose" manufacturing industries. The Nation's only producer of nickel is located at Riddle, Oregon.

Water resource development to date has been primarily for irrigation, flood control, hydroelectric power, and navigation. Nearly 1.3 million acres of irrigation account for about 88 percent of the total consumptive use of water in the area. Most of the hydroelectric power production is concentrated at the four dams on the Columbia River which have an installed capacity of 4,372,000 kilowatts, but some is also produced in the Willamette, Hood, White Salmon, Deschutes, North Umpqua, and Rogue drainage basins. Reservoirs on the Columbia and Willamette Rivers also provide space for flood control and water for navigation and other purposes.

The United States entered into treaties with the Warm Springs (1855) and Umatilla (1855) Indians, and allotments were made from the public domain for the Burns-Paiute Indians. Scattered public domain allotments are also found along the Columbia River in the vicinity of The Dalles and Hood River.

The water and related land resource needs are summarized in table 15. Much of the land is highly erosive, and intensive land treatment measures shown under watershed management need to be employed to protect this resource and assure its capability to meet projected food and fiber needs.

Formulation of Area Plans and Programs

Walla Walla Subarea (Subregion 7)

The Walla Walla Subarea lies in northeastern Oregon and southeastern

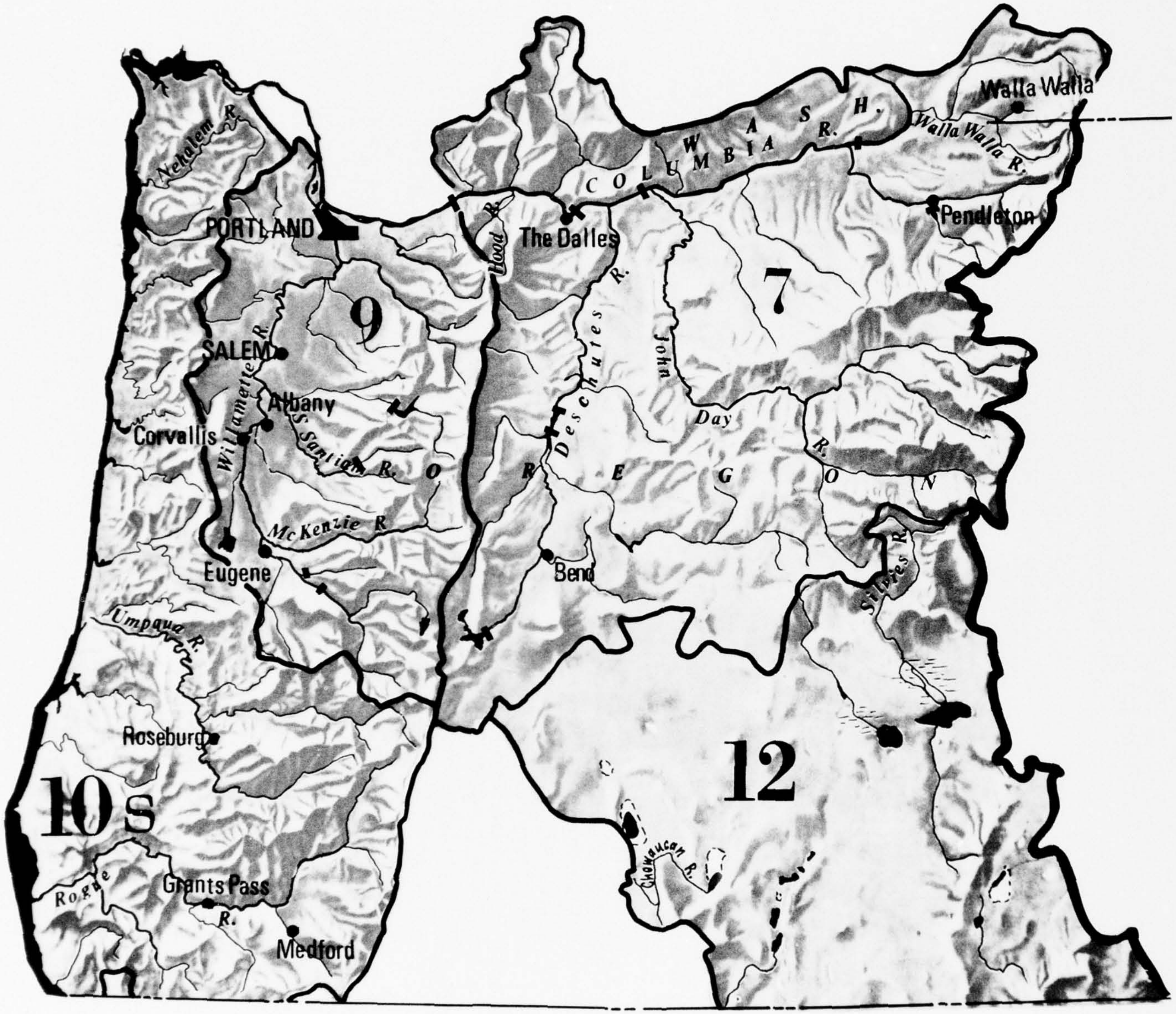


FIGURE 23. Plan Formulation Area C

Table 15—Needs Summary, Area C
Columbia-North Pacific Region

Purpose or Function	Units	Current (1970) Development	Projected Gross Needs 1980	2000	2020	Residual Needs 1980	2000	2020
Water Development and Control								
Electric Power								
Capacity (Peak)	mw	Only Projected on a Regional Basis						
Energy	mil kwh	Only Projected on a Regional Basis						
Navigation								
Commerce	1,000 tons	17,040	26,100	31,000	41,300	9,060	13,960	24,260
Water Quality Control								
Raw Waste Production 1/	1,000 p.e.	10,018	11,297	15,642	20,918	1,279	5,624	10,900
Waste Removal 1/	1,000 p.e.	7,677	9,602	14,078	18,826	1,925	6,401	11,149
Municipal and Industrial Water								
Supply	mgd	801	1,082	1,535	2,172	281	734	1,371
Municipal	mgd	(316)	(463)	(716)	(1,131)	(147)	(400)	(815)
Industrial	mgd	(432)	(554)	(736)	(940)	(122)	(304)	(508)
Rural-domestic	mgd	(53)	(65)	(83)	(101)	(12)	(30)	(48)
Flood Damages								
Major Streams 2/	Ann. $1,000	10,552	-	-	-	14,790	25,827	47,836
Bank Erosion 2/	Ann. $1,000	2,744	-	-	-	2,948	3,408	3,711
Areas Flooded 2/	1,000 ac	674	-	-	-	674	674	674
Irrigation								
Total Irrigated Area	1,000 ac	1,292	1,845	2,369	2,813	553	1,077	1,521
Water Short Area	1,000 ac	(602)	-	-	-	(602)	(602)	(602)
Water Supply	1,000 ac-ft	4,227	7,121	8,455	9,767	2,894	4,228	5,540
Water and Related Land Programs								
Fish and Wildlife								
Commercial Fishery	1,000 lbs	20,874	32,496	43,053	56,020	11,622	22,179	35,146
Sport Fishing	1,000 days	4,885	7,323	9,747	12,962	2,438	4,862	8,077
Resident Species	1,000 days	(3,030)	(4,230)	(5,646)	(7,587)	(1,200)	(2,616)	(4,557)
Anadromous, Marine, Shell	1,000 days	(1,855)	(3,093)	(4,101)	(5,375)	(1,238)	(2,246)	(3,520)
Hunting	1,000 days	2,526	3,173	4,389	5,621	647	1,863	3,095
Water Related Recreation								
Development	1,000 rec days	30,400	47,500	82,300	144,400	17,100	51,900	114,000
Required Surface Water Use 3/	acres	79,100	121,200	206,200	357,200	42,100	127,100	278,100
Land Area (Rec. Facility Develop.)	acres	9,400	27,500	48,300	90,800	18,100	38,900	81,400
Pleasure Craft	no. (1,000s)	107	159	313	584	52	206	477
Watershed Management								
Flood Damages—Minor Streams 2/	Ann. $1,000	6,153	-	-	-	7,885	10,962	15,527
Area Flooded 2/	1,000 ac	672	-	-	-	672	672	672
Erosion and Sediment Control	1,000 ac	3,519	5,303	8,086	11,298	1,784	4,567	7,779
Drainage	1,000 ac	217	359	545	734	142	328	517
Beach Erosion Control	miles	-	-	-	-	27	27	27
Bank Stabilization	miles	565	1,811	3,309	4,766	1,246	2,744	4,201
Levees and Floodwalls	miles	295	772	1,424	2,078	477	1,129	1,783
Channel Improvement	miles	1,695	4,502	7,243	9,426	2,807	5,548	7,731
Protection and Management 4/	1,000 ac	32,429	33,669	34,296	34,394	26,847	27,474	27,573
Water Conservation	1,000 ac	1,255	1,799	2,305	2,760	544	1,050	1,505
Water Yield Improvement	1,000 ac	0	20	52	109	20	52	109
Related Land Production								
Croplands	1,000 tons	4,692	6,061	7,523	9,676	1,369	2,831	4,984
Irrigation	1,000 tons	(2,241)	(3,573)	(5,393)	(7,600)	(1,332)	(3,152)	(5,359)
Dryland	1,000 tons	(2,451)	(2,488)	(2,130)	(2,076)	(37)	(-321)	(-375)
Forest Wood Fiber	mil. cu. ft.	1,821	1,809	1,932	2,020	-12	111	199
Range Grazing Capacity	1,000 aum	2,086	2,543	3,227	3,941	457	1,141	1,855

1/ Includes municipal, industrial, and recreation use.
2/ Needs over 1970 level of flood prevention.
3/ Needs are a function of recreation day requirements.
4/ Includes recurrent programs that will require acceleration with implementation of a plan. Residual needs cannot be determined by subtracting current development from gross needs as many of these practices are applied annually on the same areas.

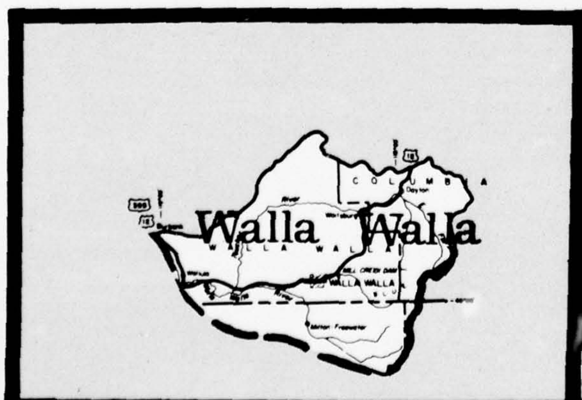
The irrigated lands comprise 27,200 acres in Oregon and 41,900 acres in Washington. A large portion of these lands, 16,100 acres in Oregon and 34,900 acres in Washington, do not receive a full water supply. The largest potential for further development exists in Washington where 580,400 acres of the subarea's 658,400 acres of potentially irrigable lands are located.

The only shortage in municipal water supplies is at Dayton; the other municipalities, except Walla Walla, have water supplies readily available to meet future needs. Industrial water use is heavy. Waters of Walla Walla River, Mill Creek, and the Touchet River are of poor quality below their headwaters; although wastes from food processing at Walla Walla cause the greatest problem, wind blown soils contribute sediment. Dilution could help but would not solve the entire problem because more water would be required than is available from these watersheds. Consequently, measures such as advanced waste treatment, selective siting of industrial plants and irrigation with industrial waste water would have to be used to accomplish a major part of pollution abatement.

Steelhead trout, which migrate when streamflows are high, are the only anadromous fish present in the Walla Walla River. Former runs of spring chinook and coho salmon have been eliminated by pollution, uncreened diversions, and low

Washington and consists of the Walla Walla River drainage. The economy is based largely on agriculture. It produces a variety of irrigated crops and is the center of a major dryland grain and pea-producing area. The southern part of the subarea is mountainous and forested.

Serious flooding occurs along the Touchet River from Dayton to Waitsburg, along the lower Walla Walla River, and along the 5-mile reach of Mill Creek directly below Walla Walla. Damages are projected to increase nearly threefold by 2020 unless protective measures are undertaken. About 173,000 acre-feet of storage necessary to fully control the floods could be provided. To supplement control by reservoirs, levee and channel work would also be needed.



Flood control channel at Walla Walla, Washington (USCE).

flows. However, improved flows in the Walla Walla River downstream from Milton-Freewater would make it possible to reestablish spring chinook and coho salmon. Also, passage facilities should be improved at Mill Creek Dam and at two diversion dams on Yellowhawk and Mill Creeks.

One of the major factors in meeting hunting and other wildlife needs is the protection of prime wildlife habitat. The most important areas, because of their value to deer and elk as winter range, are canyons in the Blue Mountains from elevation 1,800 feet up to the national forest boundary and Touchet River drainage above Dayton.

The Walla Walla Basin will experience difficulty in stretching its water resources to meet projected demands for municipal, industrial, and irrigation supplies, and streamflow augmentation. There are several possibilities for providing additional water including ground-water development, reservoir construction, and importation from the Snake or Columbia Rivers. Reservoir construction appears to be the most practical because of the need for flood control storage, the limited ground-water supplies, and the expense associated with importation. Also, the plan must respect the State of Oregon's position prohibiting out-of-state use, diversions, or appropriations of water located within the State except with the consent of the legislative assembly. The plan includes storage totaling about 125,000 acre-feet in Washington and 136,000 acre-feet in Oregon. Two major reservoirs, Dayton (authorized for construction) and Blue Creek, would be located in Washington on the Touchet River and Mill Creek, respectively. In Oregon, one major reservoir, Joe West, would be located on the Walla Walla River upstream from Milton-Freewater and a small watershed project, Hudson Bay, would be located in the Pine Creek-Dry Creek area. Because of limited local water supplies, some pumping from the Columbia River is required.

In addition to flood control storage, the Touchet River at Waitsburg and the 10-mile reach of the Walla Walla River downstream from Milton-Freewater would be protected by channel and levee projects. A long-range channel improvement project of Dry Creek would complete the major flood control works. Flood plain regulation would prevent construction of damageable structures in the flood plain. A 5-mile channel modification would provide flood control along lower Mill Creek below the existing channel improvements but a better solution would be multiple-purpose storage above the city of Walla Walla. Such storage would also provide water for irrigation and augment flows in Mill Creek and the Walla Walla River for fish life and water quality.

Irrigation water supplies, primarily from storage, would firm up supplies for water-short lands and serve a moderate amount of new land along the Touchet River and in other areas of the Walla Walla Basin. A total of 93,000 acres of new and 51,000 acres of inadequately supplied lands would be irrigated in Washington and Oregon. To meet irrigation needs, 77,000 acre-feet of storage are planned on Dry and Whetstone Creeks in Washington and 3,400 acre-feet in Vansycle Canyon in Oregon. A small watershed project on the Walla Walla River would provide water for both new and supplemental irrigation. It would also provide flood protection,

erosion control, drainage, and benefit other land treatment measures. Six other watersheds would be studied for ability to help water supply and water and soil conservation.

Most municipal and insutrial water needs would be met locally, although reservoirs in the plan would provide 6,000 acre-feet annually to Walla Walla and 1,000 acre-feet to Dayton. Water quality would be improved through increased flows provided by storage projects and treatment.

Summer and fall streamflows in the Touchet River, Mill Creek, and the Walla Walla River would be augmented to improve fish habitat and recreation values. In addition to the fishery provided by the reservoirs, increased flows and improved water quality would enhance stream fishing for both resident and anadromous fish. Improved fish passage at dams on Mill Creek and Yellowhawk Creek would complement these measures. Wildlife benefits would result from the preservation of certain key areas and the development of the lower Walla Walla River for waterfowl hunting.

Umatilla Subarea (Subregion 7)

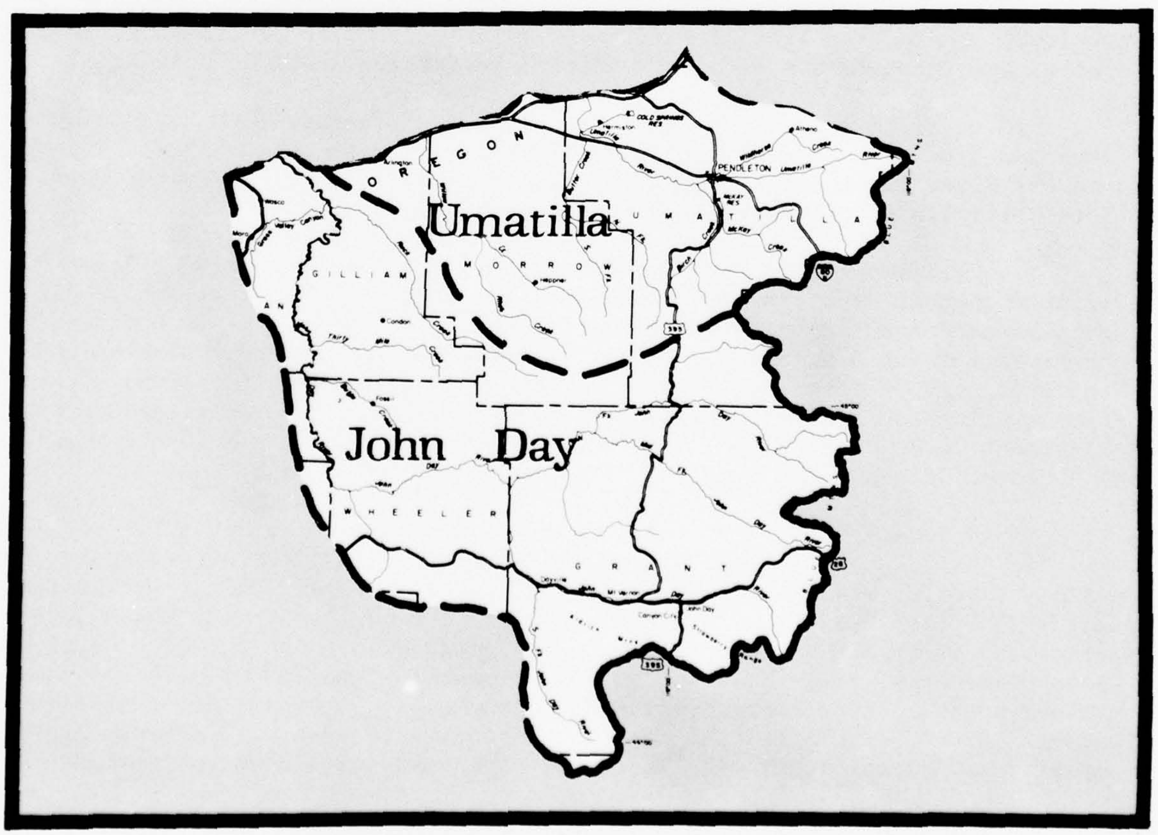
The Umatilla Subarea, which extends northwest from the Blue Mountains to the Columbia River, includes the watersheds of the Umatilla River and Willow Creek. The economy is primarily agricultural, with wheat and livestock the major items.

The sixth most disastrous flood in the history of the United States, from the standpoint of number of lives lost, occurred on Willow Creek in June 1903, when a cloudburst resulted in the loss of 247 lives in the vicinity of Heppner. Since that time, Heppner has redeveloped in its pre-flood location on the canyon floor and has suffered extensive damages from significant floodflows which recur with alarming frequency. A project with 11,500 acre-feet of storage has been authorized by Congress to protect the town from damages such as occurred in 1903. In addition to such storage, about 2 miles of channel work are needed through the town of Heppner. Flood runoff from Umatilla River and tributaries causes annual losses in the form of erosion and inundation of developments and crops. Most of this flooding occurs along the Umatilla River about 10 to 25 miles downstream from the town of Pendleton. A total of 232,000 acre-feet of storage would be necessary to fully protect Pendleton and downstream areas. A multiple-purpose reservoir on the upper Umatilla River and smaller structures on Tutuilla, McKay, Birch, and Stage Gulch, and channel and levee work on the Umatilla River in the vicinity of Echo and on Wildhorse Creek at Adams and Athena, could significantly reduce flood damages.

The water and fishing rights of the Umatilla Indians must be considered in the planning of this subarea.

Current irrigation of 65,900 acres is mostly supplied from surface sources,

Near views of devastated areas in Heppner, Oregon, after the flood of June 14, 1903 (USCE).



but nearly half do not receive adequate water; an additional 1.4 million acres are potentially irrigable. Water could be supplied by pumping from the Columbia River, from ground water, or from storage.

The city of Pendleton will need to supplement its water supply by 1975, and has applied for a right on the Umatilla River which, in conjunction with upstream storage, could meet future demands. Other communities are expected to continue to use ground-water sources which are adequate.

Although municipal waste treatment facilities are generally adequate, some need expansion as effluent in the Umatilla River reaches unsatisfactory levels during the food processing season. The community of Heppner has an adequate treatment plant, but at times must discharge its effluents into a dry Willow Creek. Stream conditions are generally good in the upper reaches of the Umatilla River, but downstream reaches are affected in the summer with bacterial contamination, algae blooms, and aquatic growths. Windblown and water-eroded soils are also a source of stream sediments.

Former runs of anadromous fish have been essentially eliminated from subarea streams by diversions and developments. However, potential remains to regain a portion of the past production if flow augmentation and passage can be provided. There is a lack of sufficient water surface for recreation; development of new impoundments with recreational facilities would be beneficial.

In order to meet needs, the subarea's water supply would have to be supplemented from outside sources. Diversions from the Columbia River and from the John Day River Basin appear to be the most likely. Storage at one or more sites on the Umatilla River system is also recognized as a need.

The framework plan includes construction of the authorized reservoir and improved channel on Willow Creek at Heppner to control flooding. These developments would prevent 86 percent of the damages in the Willow Creek Basin. Channel and levee work on 5 miles of the Umatilla River in the vicinity of Echo and Pendleton, and another 5 to 6 miles on tributary streams at the towns of Helix, Athena, Pilot Rock, and Stanfield also are contained in the plan. Flood plain management would be instituted to control developments along McKay, Tutuilla, and Wildhorse Creeks and the Umatilla River above and below Pendleton.

The plan also contains provisions for storage of 430,000 acre-feet in the Umatilla Basin to supplement water supplies for 18,000 acres of presently inadequately supplied lands and bring 102,000 acres of dry lands under irrigation, including 5,100 acres of Umatilla Indian Tribal land. The project should enhance recreation by creating and providing public access to about 8,000 acres of water. Proposed reservoirs in the plan would also benefit fish and wildlife by providing minimum pools to support fish, flow augmentation, and temperature control on the Umatilla River, enabling it to support salmon runs, and providing nesting habitat and attraction for waterfowl. In addition, the plan includes purchasing or leas-

ing 82,000 acres of key wildlife habitat, improving 146,000 acres of habitat, and constructing 270 miles of fence. Flows provided by the project, coupled with adequate waste treatment facilities, would meet water quality objectives. The project would reduce, but not completely eliminate, flood hazards on the major streams. The Columbia River would be the source of supply for about 70,000 acres of irrigation development needed along the south side of the river. An additional 600,000 acres would be treated to reduce erosion.

Projected municipal and industrial water needs, with the exception of those of the city of Pendleton, would be met from available ground water. Pendleton's needs are expected to be provided for by the proposed reservoir on the Umatilla River.

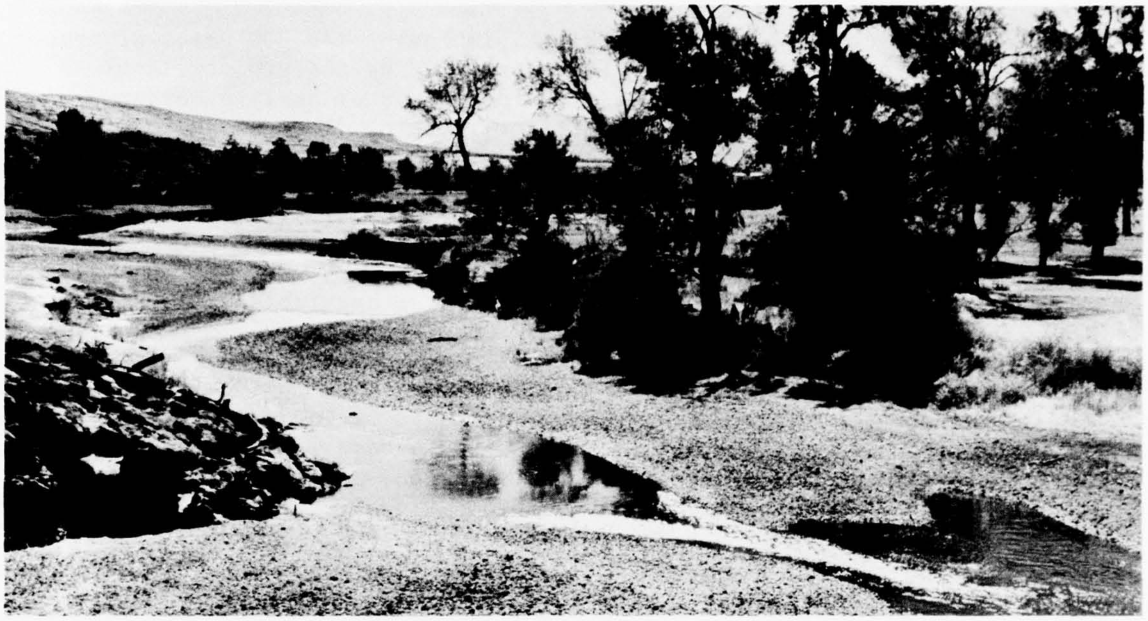
Six additional watershed projects are also included, Tutuilla Creek, Wildhorse Creek, Boardman, Sixmile Canyon, South Butter Creek, and Rhea Creek, for the primary purpose of furnishing supplemental water for 2,800 acres and 21,300 acres newly irrigated cropland. Project considerations include drainage of 2,000 acres of cropland, flood reduction on 11,300 acres of rural and 120 acres of urban lands, and reduction of erosion and sedimentation damage on over 237,000 acres of upper watersheds. Also included in the six projects are facilities for recreation, and fish and wildlife.

John Day Subarea (Subregion 7)

Located in north-central Oregon, the John Day Subarea is composed of the John Day River drainage, an area of canyons, grass-covered hills, and forested mountains. The economy is dependent primarily upon the lumber and agricultural industries.

The majority fo flood damages occur in the extensively cultivated upper valley from Prairie City to Picture Gorge. About 178,000 acre-feet of storage space is needed to fully protect this reach, including 28,000 acre-feet on both Canyon and Beech Creeks. At Mt. Vernon, levees would be required along about 6.2 miles of the John Day River, plus about 1.6 miles along Beech Creek; other channel and levee works would be needed to adequately protect Prairie City, Canyon City, and Dayville. Developments on the Canyon Creek flood plain between Canyon City and John Day require regulation to minimize potential damages. From Picture Gorge to its mouth, the John Day River is in a narrow, deep valley where potential flood damages are relatively minor.

Irrigated lands are generally restricted to the stream valleys with the greatest concentration along the John Day River from Prairie City to Picture Gorge. There are some 71,500 acres presently irrigated, of which 53,500 acres are inadequately supplied. In addition, the basin contains 1,032,600 acres of potentially irrigable land, a large portion of which lies on the high benches in the lower basin. High lift pumping from Lower John Day River or Lake Umatilla



The John Day River wanders peaceably through its valley near Dayville before cutting a deep canyon through the high Columbia River plateau (Oregon State Highway Dept.).

Mt. Vernon, Oregon, on the John Day River, December 1964 (USCE).

for irrigation of these high benches has questionable economic justification.

Most municipal supplies are derived from ground water. Local shortages result from inadequately sized distribution works or inadequately developed sources, but ground water probably will continue to be the primary source. Waste loads discharged into the John Day River are not large; however, low flows, high water temperatures, and silt result in water of undesirable quality in some reaches. This adversely affects the runs of anadromous fish, including spring chinook and steelhead, and the substantial resident fishery. The fishery would also benefit from passage around a rock-slide on Big Creek and a waterfall on the South Fork John Day River.

Winter range for big game animals is critical and water projects which encroach on it without mitigation measures could seriously affect the resource.

There is a noticeable shortage of water surface, so impoundments of water could be extremely beneficial from a recreation standpoint.

There is a significant potential for producing peaking power by pumped storage on the lower John Day River using Lake Umatilla as the lower reservoir. In addition to creating considerable peaking power, the reservoirs would provide some flood control, a large water surface area for recreation, and lower irrigation pump lifts. This alternative was not included in the plan because it has significant environmental conflicts and most of the lower John Day River is in the Oregon Scenic Waterways System.

Storage sites also exist on the upper river and several tributaries where potential damages to the environment would be minor. This storage could be used to meet irrigation demands, augment streamflows, and provide recreation water surface. Storage on the North Fork John Day River does not appear justified as it would adversely affect recreation, fish, and wildlife values, and would not provide sufficient benefits. Storage on tributaries of the North Fork could increase streamflow in the lower John Day River during the summer and fall months.

Nondevelopment was considered but was rejected because the significant needs for additional water which exist in nearly all functional areas can be met with environmentally acceptable measures.

The framework plan calls for regulation of development in the flood plains and levees at Dayville, Canyon City, and Prairie City, totaling about 4 miles in length. Four small storage projects in the Butte Creek, Rock Creek, Mountain Creek, and Strawberry Creek Areas, with an aggregate capacity of 40,300 acre-feet, would provide supplemental water for 8,400 acres and full supply for 6,300 acres of new irrigation. Five reservoir projects totaling 94,000 acre-feet capacity and one 8-mile levee project along the John Day River downstream from Mt. Vernon also are included. Storage would be at the Hall Hill site on the main river near Prairie City, and in the Grass Valley Canyon, Upper John Day, Upper South Fork John Day, and Long Creek watersheds. In connection with this storage, water

would be furnished for about 16,000 water-short acres and about 11,000 acres of new lands. Two reservoir projects (Haystack Creek and Fox Creek), with a total capacity of about 19,000 acre-feet, are also planned. Fish passage facilities would be installed at barriers on Big Creek and the South Fork John Day River. In addition to on-going wildlife management programs, special funding is needed to purchase or lease 76,000 acres of key wildlife habitat, improve 56,000 acres of habitat, and construct 315 miles of fence. Through watershed management and land treatment measures, flooding would be reduced or prevented on 8,500 acres, including 30 acres of urban land; drainage would be provided on 3,700 acres of cropland, and erosion reduced on 239,000 acres. Nineteen watersheds would be studied to determine which ones can be developed to help supply these and other needs.

Deschutes Subarea (Subregion 7)

Extending along the east side of the Cascade Range for 180 miles, the Deschutes River drainage is an area with high scenic and recreation values ranging from forested mountains to deserts. Agriculture, timber, and recreation are the principal industries.

Several storage reservoirs have been constructed on the headwaters of the Deschutes River and Crooked River, primarily for irrigation, and on the lower Deschutes River for power. Ground-water development has not been significant, largely because it is available only in small amounts in some areas while in others its depth discourages development.

The Warm Springs Indian Reservation, which is entirely within the basin, covers roughly a 35-mile square area extending from Deschutes River westward nearly to the crest of the Cascade Range. Warm Springs River, Mill Creek, Whitewater River, and portions of Lake Simtustus and Billy Chinook Lake are within the reservation. In addition to fish and wildlife, recreation, and timber resources, the reservation contains several large blocks of potentially irrigable land. At the present time, no plans have been identified to irrigate these lands, and it is estimated that other water needs can be met from within the reservation. However, existing water rights of the Warm Springs Indian Reservation must be considered in the planning of the Deschutes River Basin. In the lower Deschutes River below the Indian Reservation, the State of Oregon has withdrawn waters from further appropriations.

Because of its even flowing characteristics, the Deschutes River has practically no flood history except for the major flood of December 1964, when railroad and highway facilities were damaged along the lower 85 miles of the river; damages also occurred on some tributaries.

Irrigation water is currently applied to 256,400 acres, mostly in the Deschutes and Crooked River valleys. Large seepage losses in canals and laterals

The Deschutes subarea is a prime recreation area in Oregon (USFS).

contribute to a relatively high annual diversion to these lands of 1,264,000 acre-feet. However, an additional 70,000 acre-feet would be required annually to provide all of them with a full supply. The subarea also has 1,482,000 acres of potentially irrigable land.

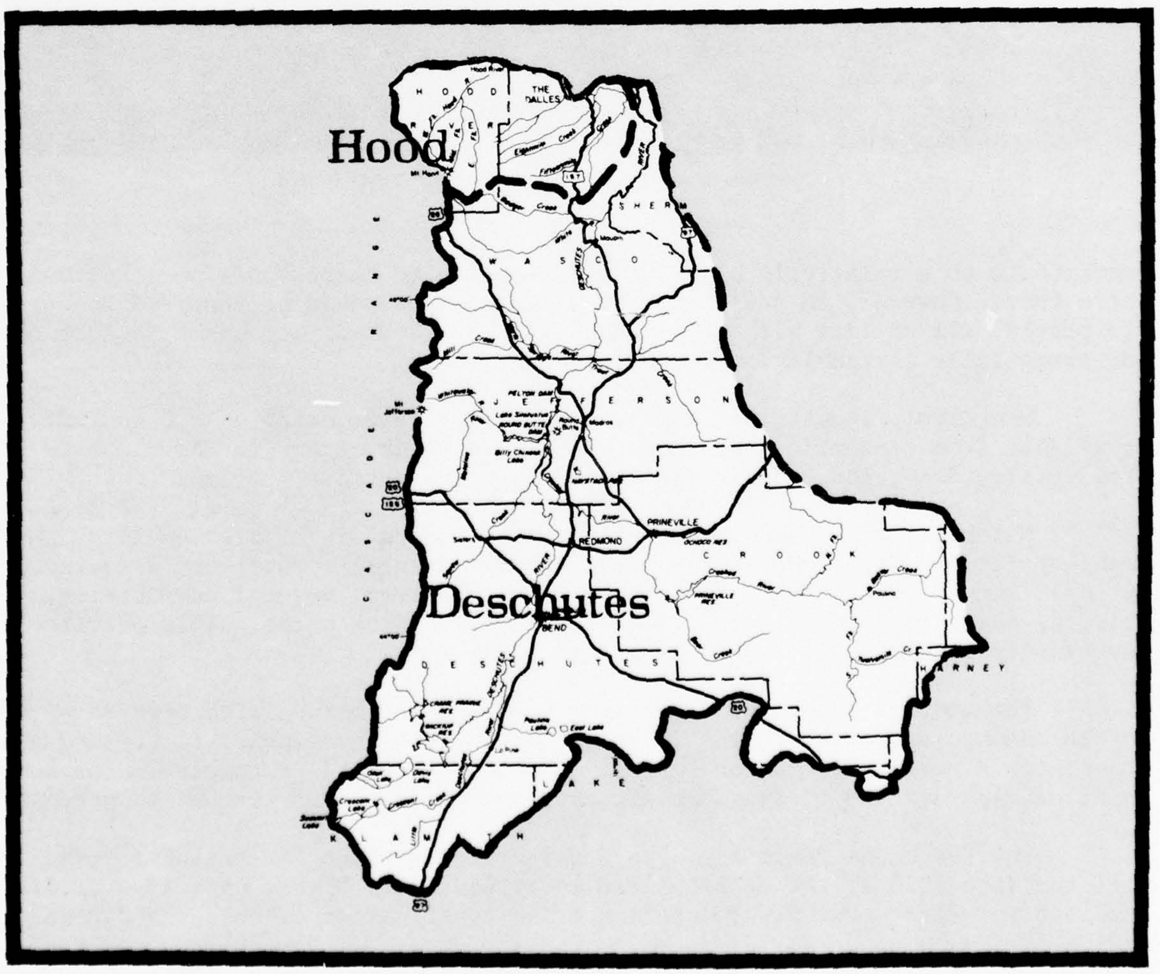
Municipal, industrial, and rural-domestic water supplies are generally available from streamflow and ground water. However, areas in the vicinity of Prineville, Bend, and Redmond could benefit from upstream storage.

Waters of the Deschutes River and tributaries are of high quality. Most municipalities utilize effective treatment and disposal practices, allowing only a small amount of wastes to enter waterways. However, several communities, including Bend, dispose of untreated wastes in lava sink holes. This practice will eventually contaminate the ground water.

The most serious land management problem is erosion, with over 80 percent of the damage occurring in the lower basin below the confluence of Crooked and Deschutes Rivers. Protection against erosion of topsoil, accumulation of sediment on highways and in drainage ditches, and pollution of streams is necessary.

The Deschutes River Basin is a prime fishing area for resident fish. Until the late 1950's, the Metolius and lower Deschutes Rivers were also excellent habitat for anadromous fish; but, since the construction of Pelton and Round

The General Patch Bridge area on the Deschutes River in central Oregon (Oregon State Highway Commission).



Butte Dams, anadromous fish runs have been limited to the lower Deschutes River system. Fish needs include flow augmentation, habitat preservation and improvement, removal of barriers, and artificial propagation. The key to meeting future hunting needs rests heavily on the preservation of existing habitat and the provision of additional habitat to provide a base for intensive management activities. The Deschutes River below Pelton Dam is in the Oregon Scenic Waterways System and has been selected for study under section 5(d) of the Wild and Scenic Rivers Act.

The Deschutes subarea includes some of the most popular recreation areas in the State of Oregon. Among these are reservoirs, the many lakes in the Cascades, the Deschutes and Crooked River canyons, the Metolius River, and other streams. With this variety of assets, the need for additional water surface is not critical; rather it is more important to maintain a balance between free-flowing stream segments and storage opportunities.

Potential new sources of water include bypassing an 8-mile reach of the Deschutes River upstream from Bend, which has seepage losses of 35,000 acre-feet annually, and lining existing irrigation canals and laterals to save about 250,000 acre-feet annually. Other possibilities include utilizing unassigned storage in Prineville Reservoir of 82,500 acre-feet, drilling for ground water, and constructing new reservoirs.

Alternatives considered include nondevelopment and several multiple-purpose plans which would provide new water supplies to meet projected needs. Nondevelopment does not appear to be acceptable in view of the projected water needs. Nearly all of the multiple-purpose plans involved storage; the primary problem was determining which streams or reaches of streams should be free of impoundments. It was concluded that the main stem of the Deschutes River and certain other selected streams are unique valuable resources which could provide the greatest benefits by being managed in that manner. Consequently, the potential bypass canal upstream from Bend was rejected.

The framework plan provides for a flood plain management program to control development in the Prineville area and a small channel improvement project in Juniper Canyon. Further studies are necessary to determine the nature of additional Crooked River flood protection. Planned storage and watershed treatment would reduce or prevent flooding on 9,100 acres of rural land and 600 acres of urban developments. Other watershed measures would reduce erosion on over 275,000 acres, mostly in the upper watersheds, and provide drainage for 3,800 acres of cropland.

Planned irrigation developments would include 546,000 acre-feet of storage in 19 new reservoirs to serve 107,000 acres of dry land and supplement supplies to 113,000 acres of water-short land. In addition, 82,500 acre-feet of unassigned space in Prineville Reservoir would be used. Over half of the new storage would be in two reservoirs, Big Marsh on a minor tributary of the upper Deschutes River and Big Prairie on the North Fork Crooked River. The remaining

relatively small reservoirs and the lands to be irrigated would be scattered throughout the subarea. Twenty watersheds would be studied to determine those which would aid in water and land conservation.

Municipal and industrial needs would be met from local sources, including Prineville Reservoir.

Recreation and resident trout fishing opportunities, already plentiful, would be further enhanced by the new reservoirs. Big Marsh and Big Prairie Reservoirs alone would create 16 square miles of water surface above 4,000 feet in elevation. Minimum flows of 100 cfs below Wickiup Dam would be provided and summer flows below Bend would be improved. Recommended minimum fishery flows of 5,000 to 6,000 cfs could not be met in most years in the lower Deschutes River as the mean annual flow is only 5,186 cfs. Preliminary studies indicate a year-round deficiency of about 1,500 cfs.

Basic fish and wildlife habitats would be assured by the preservation of special wildlife areas and the free-flowing portions of Deschutes River, Metolius River, Quinn River, Little Deschutes River, and Crooked River downstream from Prineville Dam. Fish passage facilities at the falls on White River and a tributary, Jordan Creek, would provide anadromous fish access to a new stream system. Fish passage facilities would be provided at three small dams on the Deschutes River and one on the Little Deschutes River. In addition to ongoing wildlife management programs, special funding is needed to purchase or lease 22,000 acres of key wildlife habitat, improve 35,000 acres of habitat, and construct 34 miles of fence.

Hood Subarea (Subregion 7)

This subarea is primarily an agricultural and forest area abutting the Columbia River in north-central Oregon and includes all south-side tributaries to the Columbia River in Oregon between the Deschutes River and the crest of the Cascade Mountains. One of its greatest assets is the outstanding mountain scenery.

The Hood River and its tributaries experience limited flood damages as most of the streams flow in deep, rock-walled canyons with little development. However, about 800 acres of cropland in the Hood River Basin are flooded frequently, and some 3,300 acres along Fifteenmile and Eightmile Creeks also have flood problems.

Of the 41,800 irrigated acres in the subarea, about 90 percent are supplied from surface water and 10 percent from wells. Most of the land is adequately supplied, although 5,900 acres, served primarily from wells, need additional water. There are also over 200,000 acres of potentially irrigable land, a large portion of which lies in the eastern part of the basin between Eightmile Creek and the Deschutes River above 1,000 feet in elevation.

The Hood River Valley with towering Mt. Hood as it forms a backdrop for colorful farm areas in the valley (Oregon State Highway Commission).

Although municipal and industrial water use is projected to increase about 2-1/2 times by 2020, few potential problems are foreseen in meeting future demands from available surface and ground-water supplies.

Present waste treatment is relatively poor. Hood River is affected by bacterial contamination, depressed oxygen levels, and excessive algae blooms and aquatic growths. The primary contributor, the lumber and wood products industry, is not expected to expand significantly.

Streamflow depletions during the annual low flow period have reduced the number of anadromous fish spawning in Hood River and several of the smaller streams. Low flows impair fish passage at the Powerdale diversion on Hood River, the East Side Irrigation Company's diversion on the East Fork of Hood River, and in the lower reaches of Eightmile and Fifteenmile Creeks. Fish passage also is needed around a cascade on West Fork Hood River.

The recreation attractions are Bonneville Dam and fish hatchery, Lost Lake, The Dalles Dam, Mt. Hood, the Columbia River Gorge, and the fruit orchards of Hood River Valley. Water surface for recreation is adequate, and future needs could be met by expansion of facilities and accessible shoreline areas.

Water resource development opportunities are few, primarily because stream

gradients are generally too steep to offer desirable reservoir sites. Consequently emphasis in the plan is placed upon nonstructural measures and development of a few storage sites on smaller tributuaries. Irrigation of large blocks of land by pumping from either the Deschutes or Columbia Rivers appears to have limited potential because of the high lift involved and the legal restraints on use of flows from the lower Deschutes River.

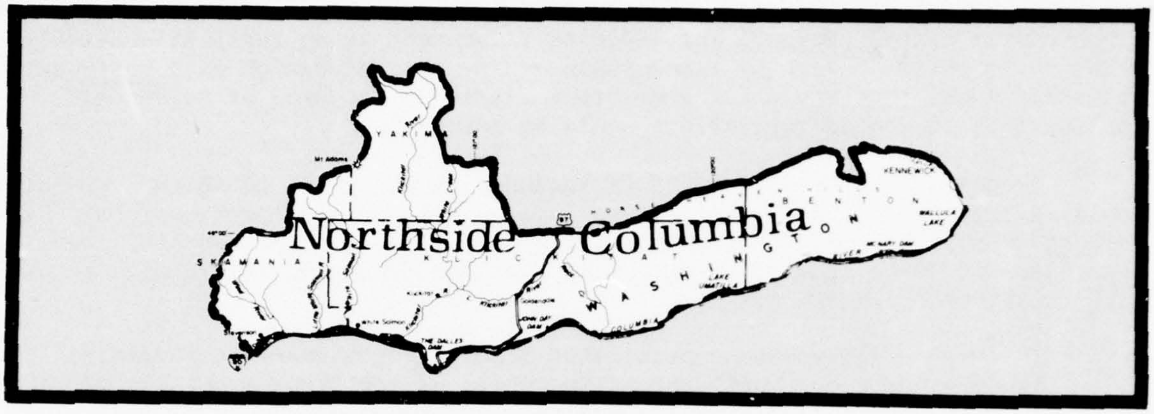
The framework plan includes storage totaling 58,300 acre-feet on Fifteenmile Creek, Eightmile Creek, East Fork of Hood River, and Green Point Creek to provide irrigation water for 8,800 acres of new lands, firm up supplies on presently irrigated lands, reduce flooding along Fifteenmile and Eightmile Creeks, and provide minimum flows in both streams for fish. Water supplies to irrigate 1,900 acres of new lands would come from the Columbia River and 5,100 acre-feet of storage on Mosier Creek. Over 52,000 acres would be treated to control erosion, thereby protecting structures and water from sediment damage. About 3,500 acres of cropland would be drained to allow diversified cropping. Six watersheds would be studied to determine where those practices should be applied. Fish passage would be provided on West Fork of Hood River, and the low flow problems at Powerdale allievated. Although no streams are proposed for preservation, a number of wildlife areas have been identified which should be protected. In addition to ongoing wildlife management programs, special funding is needed to purchase or lease 10,000 acres of key wildlife habitat, improve 15,000 acres of habitat, and construct 30 miles of fence to protect wildlife habitat.

Northside Columbia Subarea (Subregion 7)

This subarea is in south-central Washington, extending along the Columbia River from the Cascade Mountains east to Kennewick. All major streams are in the western half of the subarea; the eastern half consists of dry grass-covered hills. The economy depends on lumber and agriculture.

The primary flood problems occur from high flows in Zintel Canyon, and Little Klickitat River and tributaries. Zintel Canyon, a normally dry water course, floods residential and industrial districts of Kennewick, and needs immediate attention.

About 48,200 acres are under irrigation with the largest unit located in the Kennewick area. Adequate irrigation water supplies, primarily from surface sources, include about 118,000 acre-feet of local water and 100,000 acre-feet obtained from the Yakima Subregion. There are about 1 million acres of potentially irrigable lands in this basin. The subarea contains a portion of the extensive Yakima Indian Reservation. White Creek and the upstream portion of the Klickitat River are within this reservation. A considerable amount of potentially irrigable land is located within the reservation boundaries in both Subregion 7 and Subregion 3; the Klickitat River would be a logical choice to irrigate these lands. Water resource planning must consider these potentials and the existing water rights of the Yakima Indian Reservation.



Municipal and industrial water requirements can be met from present sources with the possible exception of Goldendale, which may require storage of up to 500 acre-feet. Even though most water treatment facilities are in need of upgrading, no critical pollution problems exist. Except for seasonal siltation problems, waters are of high quality, and conditions in the future are expected to be similar. Raw wastes would be adequately treated prior to discharge to the streams.

The only existing hydroelectric installation, Condit Dam on the White Salmon River, is operated by Pacific Power & Light Company. Klickitat Public Utility District applied for a license from the Federal Power Commission on April 15, 1963 (FPC Project No. 2241 Wash.) to construct a dam on Ninefoot Creek and powerhouse on Trout Creek, all tributaries of the White Salmon River. There is also potential for pumped-storage in the White Salmon drainage.

The Klickitat, Wind, and White Salmon Rivers are particularly valuable to fish and recreation which warrant consideration for preservation and enhancement. However, improved low flows for water quality are needed in the Little Klickitat River. Condit Dam blocks anadromous fish use of the White Salmon River; this stream also carries a heavy load of glacial flour. The subarea contains a considerable amount of wildlife habitat, protection of which is important to meeting hunting and other wildlife needs.

The plan selected provides for a study of Wind River to determine whether it should be retained in its free-flowing state, and for storage and other structural developments on the White Salmon River, Klickitat River, and Zintel Canyon in the interest of recreation, irrigation, flood control, fisheries, and power. Storage on the Klickitat River would supply water for Goldendale and for irrigation on the Yakima Indian Reservation in Subregion 3. Other storage would include about 100,000 acre-feet in two reservoirs on Rattlesnake Creek and West Fork Major Creek in the White Salmon River Basin, and about 6,000 acre-feet in Zintel Canyon.

A channel modification project would complete the flood control measures proposed for Zintel Canyon. The flooding at Goldendale on the Little Klickitat River would be dealt with by flood plain zoning in conjunction with upstream storage. As storage would not completely eliminate flooding at Goldendale, continuation of zoning regulations would be necessary.

Irrigation of 221,700 acres is included in the plan, of which over half would be irrigated with Columbia River water. Soil erosion problems would be corrected on about 532,000 acres, and 5,000 acres of cropland drained. Ten watersheds would be studied to determine the most effective combination to help make these improvements.

The Wind River would be maintained free of impoundments. Facilities to allow fish passage over Condit Dam on the White Salmon River are included in the plan. Wildlife habitat of high productivity or potential should be preserved.

Hydroelectric power production would be enhanced by the construction of the Ninefoot Creek power project. Potential also exists for use of the reservoir for a resident trout fishery and as a settling pool for a part of the glacial four which seasonally colors the lower river. Construction of the reservoir in conjunction with the planned fish passage at Condit Dam would develop the potential of White Salmon River recreation and fish producting capabilities. The increased anadromous fish production which would be realized would partially satisfy the projected regional need for anadromous fish.

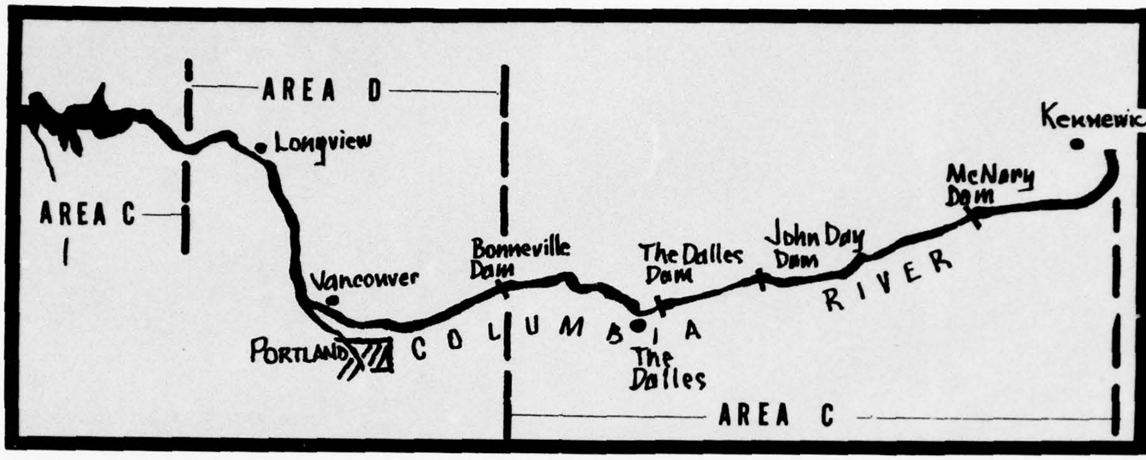
Main Stem Columbia River (Subregions 7, 8, 9, and 10S)

Area C includes the lower 50 miles of the Columbia River and the reach from Bonneville Dam up to the mouth of the Snake River.

Four major dam and reservoir projects, Bonneville, The Dalles, John Day, and McNary, have an existing electric power capacity of over 4,000 MW with an additional 2,500 MW under construction or authorized. In the future, these powerplants would be used more and more for peaking operations with large thermal plants picking up the baseload. Additional generators would be required at most of the existing hydroplants to fully utilize available water for peaking purposes. Optimum peaking operations could fluctuate the water levels, thereby changing the river's environmental values and its desirability for other uses.

A deep-draft navigation channel is maintained from the mouth of the Columbia upstream 106 miles to Vancouver, where it is succeeded by a shallow-draft channel of 15-foot depth to the Pasco-Kennewick area. Locks are installed at the four dams upstream from Vancouver to permit through navigation.

There is a need for additional waste treatment at several towns which have only primary treatment. High levels of nitrogen supersaturation, high water temperatures, and contamination by wastes should be prevented. The nitrogen pro-



blem is expected to decrease as a result of modification of spillways and power intakes, development of new storage, and expansion of generating capacity at existing dams.

Pleasure boating use, both by local residents and by boaters living out of the area, is expanding. Existing marinas are being expanded and new ones constructed.

The river has geologic, historic, and unique areas, as well as high environmental values, including fish and wildlife, recreation, and esthetics. The reach between Bonneville and McNary Dams is a fishing area for Indians which was established by treaties in the 1850's. Shorelands have a wide range of use for industry, residences, recreation, and wildlife.

Opportunities for development generally relate to operation of existing structures since the river in this reach is essentially committed from a water control point of view. Consequently, the major decisions will relate to possible operating criteria with minimum environmental impacts. Because of the complex nature of this problem, additional investigations are part of the framework plan. However, for the purpose of this framework study, increasing power production and provision of water supply for irrigation, municipal, and industrial purposes appeared warranted in view of the projected future needs.

Additional power units would be added to Bonneville, John Day, and McNary Dams, increasing the total capacity by 1,440 MW. In addition, a considerable amount of power must be generated by thermal means in order to meet the projected power demand. A substantial portion of this generation could be produced in the Mid Columbia area where adequate water for cooling purposes is available. Because once-through cooling may increase the temperature of the river, other means for dissipation or use of heat should be considered including use of water for irrigation. In total, 15,000 MW of thermal-electric capacity are planned for 2000, followed by another 25,000 MW between 2000 and 2020.

One of the region's most noted scenic attractions is the Columbia River Gorge (Oregon State Highway Commission).

Specific measures for the enhancement of navigation are improved port facilities at Astoria, improved lock approaches at John Day and McNary projects, and excavation of shoal areas in the upper reaches of their pools. Bonneville lock would be enlarged to 86 feet by 675 feet, the size of the three upriver locks. The Union Pacific Railroad bridge over Columbia River below its confluence with the Snake would be modified. Additional port facilities and terminal areas would be provided by local interests.

Adequate treatment of all wastes is planned to enhance the river for such uses as passage for anadromous fish, resting area for waterfowl, fishing, boating, and other purposes.

Willamette Subarea (Subregion 9)

The Willamette Subarea, identical to Subregion 9, has an area of 12,045 square miles and a 1965 population of 1.34 million, 68 percent of the population of the State of Oregon. It includes the Willamette and Sandy River drainages.

Although much progress has been made in the last 30 years in alleviating flood problems, continuing development has expanded the potential for flood damages. A program is needed which will blend regulation of developments in the flood plain, and other nonstructural measures with reservoir, channel, and levee construction.

By 2020 an increase in irrigated land from 244,000 acres to about 1 million acres is required to meet the food and fiber requirements.

The Willamette Subregion accounts for about 25 percent of the region's electric power consumption but produces only about 5 percent. With 2020 annual energy requirements projected to increase to about 34 times the 1965 use and no major undeveloped hydroelectric sites in the Willamette Basin, it is apparent that future needs will have to be met from thermal plants, pumped storage or other peaking plants, and imports.

Present navigational improvements on the lower Willamette River are adequate. Replacement of existing locks at Willamette Falls is required along with improved channel depths and widths for full navigational use between Oregon City and Albany.

The total supplies of domestic, municipal, and industrial water are adequate, even to 2020. The major problem and the associated need will be for storage, treatment, and distribution of the water so as to make it available as needed.

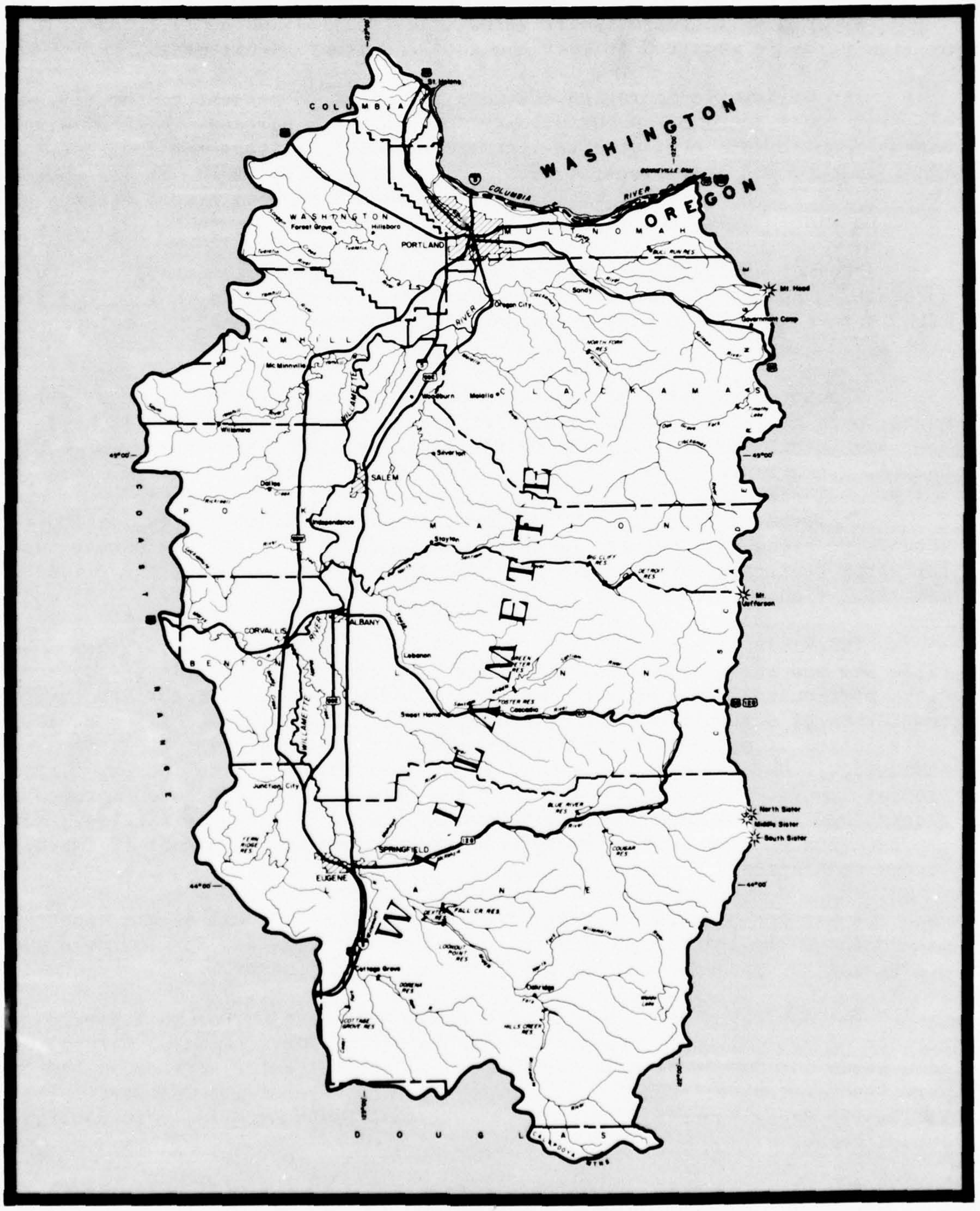
Improvement in municipal and industrial waste treatment facilities is necessary, along with augmenting summer streamflows to provide adequate quality for water contact sports and for maintenance and enhancement of the existing and potential fisheries.

The Willamette River is the largest Columbia River tributary below Bonneville Dam and has a tremendous potential for increasing supplies of anadromous fish, particularly fall chinook and coho salmon. The major needs are for the completion of screening at the Willamette Falls Fishway, controlling pollution, installation of passage facilities at barriers, and smoothing out extremes of streamflow. Natural reproduction of trout is not expected to increase beyond present levels. Measures needed to improve trout fishing include improved angler access, new fishing impoundments, and expansion of hatchery facilities. Natural reproduction of warm water game fish is expected to equal demands if improved access is provided.

A variety of wildlife exists, but future hunting demands are expected to exceed the subregion's capabilities. The primary needs are for improved hunter access and the preservation and enhancement of the habitat.

The subregion is richly endowed with natural resources that provide a variety of recreational opportunities and a quality environment. Future recreation needs include additional facilities, additional water surface in the lower part, and streams or reaches of streams retained free of impoundments. The Willamette River Parks System program will contribute materially to meeting future needs.

The plan for this subregion was formulated by the Willamette Basin Task


WASHINGTON
OREGON
COLUMBIA
WASHINGTON
MULTNOMAH
PORTLAND
Forest Grove
Hillsboro
St Helens
Sandy
Mt Hood
Government Camp
Oregon City
YAMHILL
Mc Minnville
Woodburn
Molalla
CLACKAMAS
Silverton
SALEM
Dallas
POLK
Independence
Stayton
MARION
Mt Jefferson
CORVALLIS
ALBANY
BENTON
Lebanon
LINN
Sweet Home
Cascadia
FOSTER RES
COAST RANGE
Junction City
BLUE RIVER RES
North Sister
Middle Sister
South Sister
SPRINGFIELD
EUGENE
COUGAR RES
FERN RIDGE RES
FALL CR RES
LOOKOUT POINT RES
Cottage Grove
DORENA RES
COTTAGE GROVE RES
Oakridge
HILLS CREEK RES
DOUGLAS
WILLAMETTE
LANE
DETROIT RES
BIG CLIFF RES
NORTH FORK RES
BULL RUN RES
BONNEVILLE DAM
COLUMBIA RIVER

A view showing the general characteristics of the Willamette-Puget Sound Trough (Oregon State Highway Commission).

Force for the Type 2 Comprehensive Report. Consideration was given to all available alternatives, including that of nondevelopment which was dismissed as totally inappropriate in view of the projected large demands for water and the wide range of opportunities. A basic finding was that multiple-purpose storage was needed to control and conserve water. Two principal alternatives to storage development are development and use of ground-water resources, and watershed management programs to increase low water flows. In general, the ground-water alternative was considered adaptable only to relatively limited irrigation and domestic-municipal water supply needs. Although watershed management programs would be capable of improving water quality, enhancing reservoir filling potential, and reducting siltation, they would be incapable of meeting any significant part of total downstream needs for increased flow.

Regulation of flood plain use would be an alternative to any potential single-purpose development for flood control. However, it was considered as a supplement, rather than an alternative, to the flood control function of multiple-purpose storage because substantially all flood control effects could be achieved by joint use of space required for other purposes.

The framework plan includes enlargement of one existing reservoir, rescoping one authorized, and developing 94 multiple-purpose reservoir projects with about 2,916,000 acre-feet of storage of which 38 would be required by 1980, 32 by 2000, and 24 by 2020. The plan also provides for reauthorization of existing reservoir projects to include such additional functions as fish and wildlife, municipal and industrial water supply, recreation, and water quality control.

Significant numbers of salmon are harvested from the Willamette River, near Oregon City (Oregon State Fish Commission).

The Willamette River at Portland, Oregon (Ackroyd photo).

Other programs include flood forecasting, emergency action, and local flood plain zoning or land use regulation. Structural programs would comprise channel modification of 107 miles of Willamette River and reservoir-controlled tributaries to facilitate reservoir evacuation. Additional channel projects include 63 miles on the Tualatin River, 55 miles on the Yamhill River, 46 miles on the Pudding River, and selected reaches of other tributary streams. On minor tributaries, channel work would be accomplished by 17 small watershed projects. Irrigation would be provided for 756,000 additional acres. Navigation elements consist of the authorized Willamette Falls Locks and open-channel works to provide increased depths for navigation in the Willamette River upstream to the Corvallis-Albany area. Electric power production would be increased by the addition of 39.5 MW generating capacity at the existing Cougar Project (includes Strube reregulating dam) and 35 MW of power on the Shellrock hydroplant. Also thermal plants to generate 24,000 MW of electric power would be required.

Basic elements of the water pollution control program include high level at-source waste treatment by all municipalities and industries, flow augmentation as necessary to supplement waste treatment, soil stabilization, and completion of interceptor sewer facilities in the Portland metropolitan area. Other elements are control of wastes from houseboats, ships, and other watercraft, of fertilizers and commercial toxicants, of animal waste discharge to water bodies, of urban storm runoff, and other management practices.

The existing fish hatchery program would be supplemented by expansion and replacement of outdated hatchery facilities for anadromous and resident fish. A complementary program for use of fishery resources is for state acquisition of 350 access sites to streams plus a number of oxbow lakes, borrow pits, and low-elevation impoundments. For wildlife enhancement and utilization purposes, a program of research and education, and increasing wildlife populations and hunter access is included. Specifically, it would include securing certain lands with high potential for producing wildlife, leasing and developing about 23 pigeon springs, acquiring additional waterfowl refuges and nesting and feeding areas, contracting with landowners for access to farm and forest lands, and either adopting a management plan to maintain constant levels of Fern Ridge Reservoir from May 1 to July 1 to enhance water fowl nesting or developing a system of dikes.

A study program for preservation and protection of more than 1,250 miles of natural channel and the immediately adjoining lands is an important part of the plan. The ultimate environmental management program would provide for protection of flows, water quality, and natural streamside environement. The study plan covers all but excepted portions of 29 specifically named streams, plus all streams in five wildernesses and three designated forest recreation areas.

Another phase of the plan is the development of recreation areas and facilities by the private sector, local, county, State, and Federal groups and agencies to provide for more than 10 million recreation days of use. An important element is completion of the Willamette River Parks System which was initiated in 1966 as the Willamette River Greenway. The plan calls for a committee

to coordinate recreation programs and activities.

Seventy-two small watershed projects would be designed and constructed to provide storage, flood protection, cropland drainage, water conservation, and land treatment. Land and water measures programs would be continued based upon need and capability.

Oregon Coast Subarea (Subregion 10S)

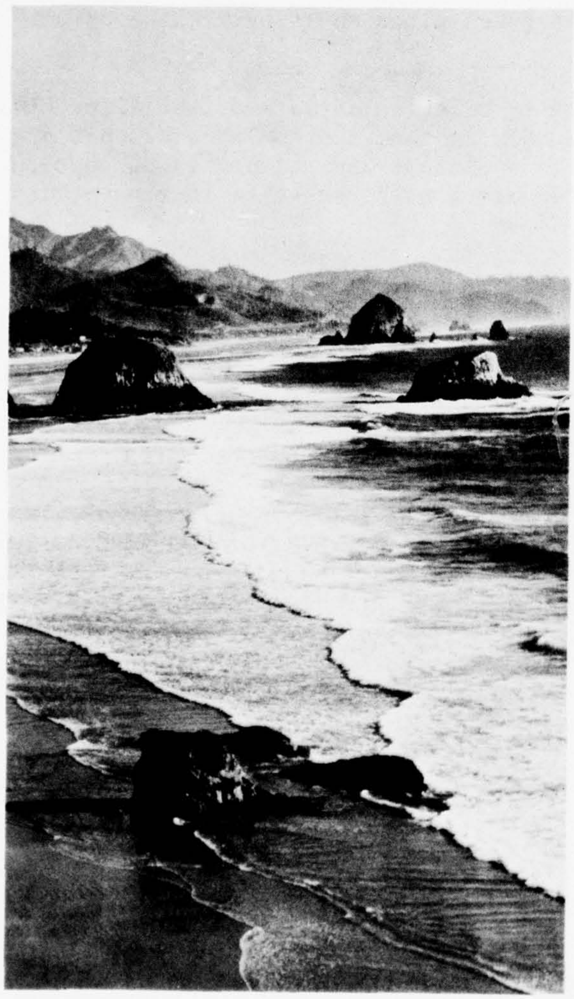
The coastal zone is the entire area of Subregion 10S except the drainages of the Umpqua River upstream from Scottsburg and the Rogue River upstream from Agness. It includes the entire coastline of Oregon from the California-Oregon Border north to and including the Columbia River estuary.

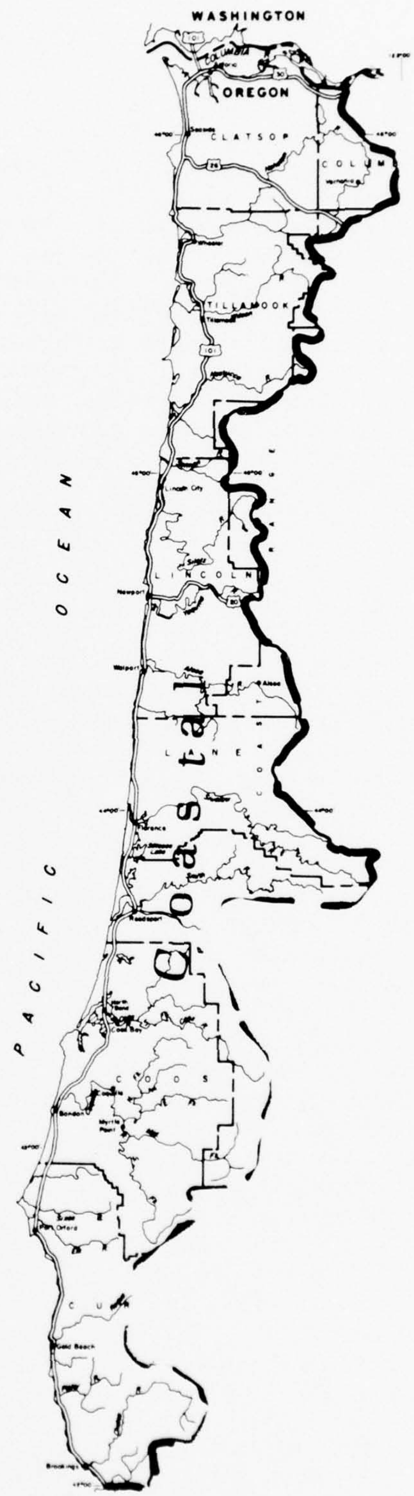
Of the approximately 350 miles of coastline, about 250 miles have usable beaches and the remaining 100 miles consist of headlands and rocky shores. On the central Oregon coast there are sand dunes of notable proportions while south of Cape Blanco the dunes are comparatively small and widely separated. Between the Siuslaw River and Coos Bay these seacoast phenomena assume proportions which are of national significance.

Approximately 83 miles of the Oregon shoreline are federally owned while 158 miles are owned by non-Federal public bodies and 238 miles are privately owned. The public right to the use, for recreational purposes, of the coastal strip seaward of the natural vegetation line has been established by the Oregon State Legislature.

Minor estuaries include the mouths of coastal streams such as the Rogue, Elk, Sixes, Pistol, Chetco, and Winchuck. The major estuaries are, from south to north, Coquille River estuary, Coos Bay, Winchester Bay (Umpqua River), Siuslaw Bay, Alsea Bay, Yaquina Bay, Siletz Bay, Salmon River estuary, Nestucca Bay, Sand Lake (small embayment), Netarts Bay, Tillamook Bay, Nehalem Bay, and Columbia River estuary (including Young's Bay). The 14 major estuaries total only slightly more than 56,000 acres but are invaluable to the region and the state because of the contribution they make to biological, economic, and social functions. Problems and conditions at individual estuaries are described in the following text:

Coos Bay Encompassing nearly 10,000 acres, nearly half of which is tidelands, Coos Bay is the largest Oregon estuary. Much recent attention has focused on this area because of the conflicts between major uses. As a deep-draft port, it is an important industrial bay with log storage, lumber shipment, pulp manufacturing, fish processing, and other commercial uses. As a result, industrial pollution in the form of log storage, tideland filling, and other use effects threaten the Bay's biological productivity. The University of Oregon's Institute of Marine Biology also is located here.





Impressive coastal seascapes are but one of the attractions at Ecola State Park near Cannon Beach, Oregon. Many recreation opportunities are offered at ocean beach areas (Oregon State Highway Commission).

Winchester Bay Winchester Bay, the estuary of the Umpqua River, covers an area of 7,500 acres. Tidewater extends 27 miles up the Umpqua to Scottsburg and 20 miles up Smith River. Both arms are used by commercial navigation to the heads of tidewater. The bay and entrance are used extensively for recreational and commercial fishing. The Gardiner-Reedsport area is a significant industrial center, but most industrial wastes are discharged directly into the Pacific Ocean by a diffuse outfall. Erosion is not a major problem.

Siuslaw River Estuary The Siuslaw River estuary covers an area of about 1,600 acres and includes approximately 8 miles of shoreline. About 0.5 miles of Pacific Ocean shore and 3 miles of shoreline in the estuary have critical erosion problems. However, recreation is the primary use of the shoreline, and no development other than for recreation has taken place where critical erosion occurs.

Alsea Bay Alsea Bay is the basically pristine estuary of the Alsea River and totals about 2,200 acres. It is valuable in that its entrance has not been stabilized with jetties and thus it offers engineers and scientists an opportunity to observe natural phenomena for comparison with estuaries that have been modified for navigation.

Yaquina Bay With nearly 2,900 acres, Yaquina Bay is an important industrial, commercial, and natural resource bay. Not only is it the hub of the central coast's growing and important recreation/tourism industry, it also is the home of Oregon State University's Marine Science Center and Marine Research Reserve. While Yaquina Bay is the only coastal estuary for which a long-range water and land use plan has been prepared, its biological production continues to be threatened by upstream land uses, waste discharges, and potential accidental oil spills.

Salmon River Estuary, Sand Lake, and Netarts Bay The Salmon River estuary, relatively undeveloped and containing about 450 acres, is an excellent area for study of intertidal zone plants and animals. Sand Lake is a scenic high-salinity embayment of about 700 acres and is in a near-primitive state. Netarts Bay is a high-salinity, nearly pristine area of about 2,400 acres which are mostly tidelands. Oregon State University has an estuary research area near Whiskey Creek which flows into the bay.

Tillamook Bay One of Oregon's larger estuaries, Tillamook Bay is an important sport fishing area and supports a significant oyster industry. The shoreline of the bay ranges from essentially no development to the developed area in the vicinity of the towns of Tillamook and Garibaldi. Erosion is a serious problem in the estuary; out of its fifty miles of shoreline there are eleven miles which are considered erosion problem areas. Some of the most critical erosion on the Oregon coast occurs along both sides of the Bay Ocean peninsula which separates Tillamook Bay from the Pacific Ocean.

The coastal zone is less urbanized than other parts of western Oregon,

but most of the larger communities are growing along their suburban fringes. Considerable public attention is being directed toward the proposed construction of powerlines, condominium facilities, and highrise buildings which may affect the attractive character of the shoreline. Siltation and discharge of wastes into streams and estuaries have deteriorated the quality of such waters, and the problem of disposition of dredging spoil is becoming acute as suitable areas become scarce. Considerable public pressure has been brought to bear within the last several years to limit or preclude highway construction on critical shoreline.

Presently there is no commercial hydroelectric power generation; however, some electric power is generated at small thermal plants at Astoria and North Bend. Potential hydroelectric sites are limited but numerous potential pumped storage sites have been identified. Thermal generating plants using ocean waters for cooling appear to be the most likely source of power generation.

Navigation at all ports is hindered to varying degrees by lack of depth in channels, periods of poor visibility, and when waves make the entrances too rough for safe transit. Deeper channels are needed in Coos and Yaquina Bays to accommodate deep draft shipping. Entrance and channel improvements in Siuslaw, Rogue, Chetco, Tillamook, Coquille, and Umpqua Rivers are needed for shallow draft barge navigation and commercial fishing vessels. Terminal facilities at these locations need expansion and modernization.

Water quality is good in most areas but the discharge of inadequately treated municipal and industrial wastes into some coastal streams and estuaries creates problems during the late summer months. Waste production and water demand for agricultural, industrial, and municipal uses are expected to increase; therefore, waste treatment programs should be accelerated.

Most of the municipal and industrial water is supplied by surface sources. Rural-domestic needs are satisfied by pumping from wells and small creeks. Ground water is important in some of the dunes areas. Streamflows are adequate to supply the needs for municipal and industrial uses in all but the low flow summer months. Small reservoirs to augment the natural streamflows are needed to assure adequate water supply on a yearly basis.

Flooding occurs on most of the coastal streams at least once every year and contributes to streambank erosion, estuarine sedimentation, and reduced farm production. Most of the streams flow in steep, narrow valleys without suitable reservoir sites in the upstream reaches; therefore, storage opportunities for flood control and conservation uses are limited. Levees and flood walls could provide protection in the tidal zone areas; however, regulation of flood plain uses appears to be the best choice to prevent increased flood damages on much of the frequently inundated land.

Development of irrigated lands has been accomplished by private enterprise. The 32,200 irrigated acres are scattered throughout the subarea, but

concentrations occur in the Tillamook area and in the Nehalem and Coquille drainages. Although potentially irrigable lands total about 252,000 acres, much of it is in narrow discontinuous tracts in the river valleys. As known ground-water supplies in sufficient quantities for irrigation use are available in only a few areas, surface water supply is assumed for most future irrigation developments.

Fish and wildlife habitat have been adversely affected by urban and industrial developments which have removed bank vegetation, channelized streambeds, removed gravel and bottom materials in spawning channels, introduced domestic and industrial waste in destructive concentrations, and dredged and filled shellfish areas of the tidal zones. To meet the hunting and fishing needs and to insure continuation of these resources require an extensive program of habitat improvement, artificial propagation, improved water quality, and flow augmentation.

Recreational areas range from the many miles of sandy beaches and scenic headlands to the vast acreages of semiwilderness forested uplands. Land, stream, and estuarine areas which comprise the generally high quality environment require protection and enhancement to meet the expected increase in demands on recreational areas and facilities. In addition to the nationally famous salmon and steelhead sports fisheries, other recreational activities include sightseeing, picnicking, camping, and boating.

Numerous measures and actions will be necessary to preserve and enhance

Erosion in the lower Coquille Valley (USCE).

the environment of the coastal zone. Widespread regulation is necessary to assure that commercial developments and private recreation developments are harmonious with their surroundings. Streams to be considered for preservation in a free-flowing state are discussed in the preservation section. Small reservoirs are needed in numerous tributary drainages to provide recreation, fishing, and improved downstream flows.

Intelligent water and related land resource planning will require considerably more hydrologic, hydraulic, and water quality data than are now available for the fresh water streams, estuaries, and marine waters. Studies must relate water quality parameters with the hydrologic-hydraulic data and the needs for fish, wildlife, recreation, and other uses of the waters. Beach erosion areas and littoral proccesses must be studied in order to increase knowledge of these aspects to the point where adequate management programs can be developed.

Construction of recreation facilities, including trails, should be continued to assure that the projected demands are met. Recreation pressures may become so great that critical deterioration of the environment and the recreation values could result by the 2000 period unless such use is regulated. Scenic roads and corridors should be expanded, particularly along U.S. 101 (the coast highway), and roads connecting the coast with interior areas. Also a state-level program to provide unified management of shoreline erosion control programs should be implemented.

Fifteen small watershed projects should be considered to combat erosion, provide drainage and flood protection, augment flows for fish, supply irrigation water to small developments, and furnish municipal and industrial supplies. Improved land management and logging practices are also needed in the extensive forested areas.

The framework plan for the Coastal Subarea includes generation of electric power for both energy and capacity. This consists of thermal plants to generate 10,000 MW of electic power using sea water for cooling; recognition has also been given to the possibility of future peaking by using pumped storage.

Navigation improvements include completion of the south jetty at Tillamook, jetty and channel work to improve entrance conditions of the Umpqua River, channel improvements at Coos Bay and Siuslaw River, improvement of the entrance and channel in the Rogue River, and three small-boat basins along the coast. Private development has already begun to expand the small-boat basins at most of the coastal ports. Lower Columbia River navigation developments include deepening the deep-draft channel through the estuary, improvement and expansion of port facilities at Astoria, and expansion of existing and construction of new small-boat moorages.

Water quality improvements would be made by increasing the levels of treatment to regional standards. Other improvements include augmentation of low

flows by small storage dams, control of erosion and sediment, and collection of wastes in harbors and berthing areas.

Municipal and industrial water supplies can generally be expanded to meet future needs but, after 1980, those in the Lincoln County area must be augmented through development of storage reservoirs and an extensive, coordinated distribution system.

Flood plain regulation programs with realistic zoning as the ultimate objective are recommended for all streams. The tributaries of Tillamook, Nestucca, and Nehalem Bays flow through high value agricultural and some urban lands. Levees are planned for Elk Creek, Coquille, Nestucca, and Nehalem Rivers, and most streams in the Tillamook Bay area.

Two small watershed projects, Lake Creek and Floras Creek, and irrigation developments using natural flows of the Necanicum River and Beaver Slough would provide irrigation water for 9,500 acres. Supplemental water for 600 acres of land presently irrigated would also be provided. Other irrigation developments would utilize water from Larson Slough, Bear Creek, North Slough, Haynes Inlet, and Nehalem River. Total irrigation development would provide water for 25,000 acres of new land and 1,000 acres of water-short land.

Multiple-purpose storage projects would be constructed at Fairview, Camas Valley, and Clear Creek to meet recreational, flood control, water quality, and fish and wildlife needs. The Fairview and Camas Valley sites would store a total of 100,000 acre-feet of water on forks of the Coquille River; the Clear Creek site would store 75,000 acre-feet on the Nehalem River.

Recreation needs would be satisfied by expansion of existing camping and picnicking facilities and construction of new facilities by local, State, and Federal agencies. All or portions of the following streams are recommended for study for preservation in their free-flowing state in the interest of recreation and fish: Miami, Kilchis, North Fork Kilchis, Wilson, Trask, North Fork Trask, Nestucca, Little Nestucca, Salmon, Siletz, Alsea, Siuslaw, Smith, Sixes, Chetco, and Elk Rivers and Lake Creek.

Storage in upper watershed areas to increase low water flows and improve water quality is desirable along with a management program for streams and adjacent land to prevent encroachment of industrial, urban, and other noncompatible development. All estuaries, and particularly the Columbia River estuary because of its regional importance as the anadromous fish gateway to the Columbia-Willamette-Snake Rivers system and as a rearing place for other marine life, must be provided adequate protection.

Another principal element of the framework plan is an interdisciplinary study to develop a comprehensive plan for management of the coastal zone. Primary areas of concern are the estuaries, those areas of high biological productivity and importance, and the unique scenic and esthetic values of Oregon's

Entrance to the Umpqua River in Oregon showing a potential improvement to the jetty system (USCE).

nationally famous shoreline. A cooperative local-State-Federal coastwide planing program is being conducted under the auspices of the Oregon Coastal Conservation and Development Commission. The program's purpose is to strike a balance between the zone's environment and economy. Accordingly, the zone's natural resources, the present economy, and future prospects represent aspects of principal concern for which planning must be carried out on an accelerated schedule.

Rogue River Subarea (Subregion 10S)

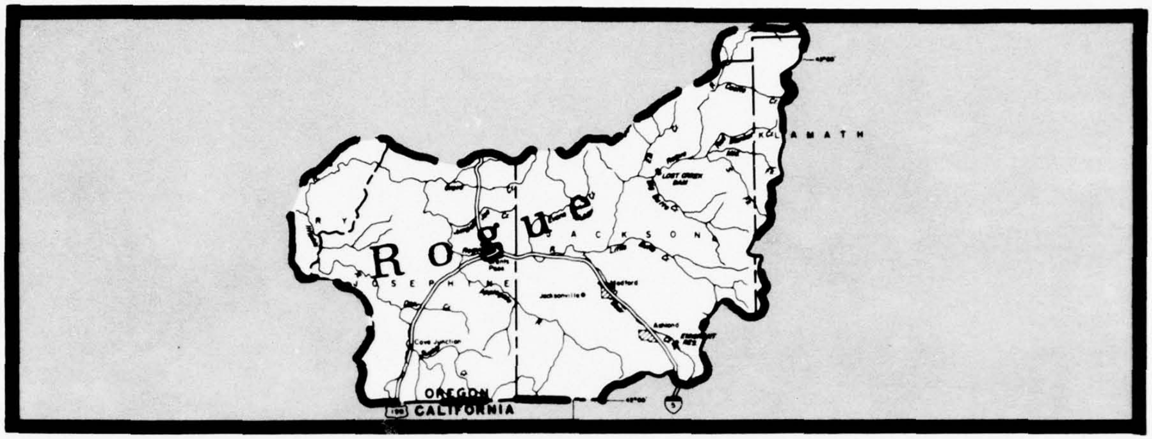
The Rogue River is the most southerly major drainage and one of the principal coastal tributaries. Flooding along the main stem of the Rogue River is confined generally to a 75-mile reach in the central part of the subarea. Above and below that reach, the river flows through deep canyons in mountainous terrain and causes little damage. Damages also occur along the tributary streams of Big Butte Creek, Little Butte Creek, Bear Creek, Evans Creek, Applegate River, Grave Creek, and the upper part of the Illinois River. Projected damages can be reduced significantly by contruction of storage reservoirs and levees and development of a sound flood plain management program. Authorized reservoirs will provide 280,000 acre-feet of flood control storage out of a total need for 1.25 million acre-feet.

Nearly 39,000 acres of the presently irrigated lands in the subarea are short of water, needing 33,000 acre-feet of water annually to reach full production. In addition, about 329,000 acres of dry land are suitable for irrigation. For the most part, however, development of any new land or supplementing of supplies for water-short lands would be dependent upon storage of streamflow.

The only identified potential for conventional hydroelectric power production is for 49 MW at the Lost Creek site on the Rogue River. In addition, eight potential pumped storage sites have been identified with individual capacities of 1 million kilowatts or more. Additional studies are necessary to determine the power production capabilities and environmental impacts of any potential development. Base power will probably be imported from other areas.

Population expansion is expected to occur in the Medford service area which includes the cities of Medford, Ashland, and Jacksonville. The largest, Medford, obtains its water from Big Butte Springs with additional water rights for Rogue River flows. Water to be stored in Lost Creek and Elk Creek Reservoirs will provide a future source. Both projects are authorized by Congress; construction has started on the Lost Creek project. Grants Pass, however, will have to use water from those reservoirs as soon as it becomes available. Other municipalities, industries, and rural-domestic users generally can expand their present supplies.

Water quality is generally adequate throughout much of the basin, but many of the smaller tributaries become virtually dry in the summer. Bear Creek through and below Medford becomes an esthetic nuisance with extensive aquatic



growths and high bacterial densities; a minimum flow of 75 cfs is needed for water quality control. The entire length of the Rogue River below Bear Creek exhibits coliform bacterial densities greater than desirable for safe water-contact recreation. Maximum temperatures often exceed 70°F. and in the canyon reach below Grants Pass temperatures occasionally exceed 80°F. Improved waste treatement facilities completed recently in the Medford area will reduce coliform densities in the Rogue River to safe levels; but, if temperatures are to be lowered to acceptable levels for fish life, a minimum flow of 2,000 cfs would have to be provided during summer months.

The state has filed on increased flows for fisheries from Federal multiple-purpose projects now under construction in upper Rogue River Basin. Also, the canyon reach of the Rogue River through the Coast Range is included in both the national wild and scenic river system and the State Scenic Waterways System. The lower 46 miles of the Illinois River also are included in the State Scenic Waterways System, and the entire river is being studied for possible inclusion in the national system.

To meet future recreation, fish, and wildlife needs, preservation should be considered for another reach of the Rogue River, from Lost Creek damsite to the Applegate River, and for the remaining portion of Illinois River from Deer Creek upstream. Once the basic stream system is safeguarded, fish numbers can be increased through a variety of other management programs. Another need is for several small reservoirs in the upper tributaries to be operated only for recreation and fishing.

Future hunting pressures can be met only through an extensive program of habitat preservation and improvement. Big game herds will depend upon protection of the critical winter ranges up to 2,000 feet elevation in the Coast Range and up to 3,000 feet elevation in the Cascade Range. The most significant wetland and water areas should be studied for possible preservation for waterflowl and other wildlife.

Not exclusively a mail boat is the Chinook, one of several such speed boats which carry tourists as well as mail from Wedderburn on the southern Oregon coast to Agness, 32 miles up the winding Rogue River. The trip is one of the highlights of any vacationer's visit to the coast (Oregon State Highway Commission).

About 22,000 acres of cropland have erosion problems, especially in the Grants Pass and Bear Creek areas. Shifts in cropland and range areas are expected to increase future erosion problems. Almost 26,000 acres of cropland need drainage, about half of which are in the Bear Creek Valley near Medford. Because of topography and stratigraphy, drainage of this area should be accomplished as a unit. Most of the remaining areas can be drained by individual landowners with some community outlets installed by small groups. Drainage problems in the Bear Creek Valley are expected to increase with the addition of irrigation water.

Although several major opportunities exist for meeting needs in the Rogue River Basin, a primary decision is whether to build a dam on the Applegate River, one of the streams identified to be studied for possible preservation as a free-flowing stream. The dam is authorized for Federal construction and is included in the plan because it would be located high in the watershed, thereby retaining the major portion of the stream in a free-flowing state. It would also provide flood control, increase summer streamflow downstream, and permit reestablishment of spring chinook salmon runs.

The nucleus of the structural elements of the framework plan would be 738,000 acre-feet of storage. The authorized dams, Lost Creek Dam on the Rogue River, Elk Creek Dam on Elk Creek, Applegate Dam on Applegate River, and Sexton Dam on Jumpoff Joe Creek, would impound most of the water with the remainder being stored on Evans Creek and Little Butte Creek. About 33,000 acres of land would be irrigated by these reservoirs and another 8,600 acres, primarily in the

Medford area, would be provided a supplemental supply. The plan would also provide 49 megawatts of electric power and future water supplies of municipalities of Grants Pass, Gold Hill, Medford, and Rogue River. Flow augmentation in Bear Creek, Applegate River, Evans Creek, Rogue River, and Little Butte Creek would improve temperatures and other quality parameters for fish and recreation.

Flooding would be reduced in several areas, including along the Rogue River from Lost Creek Dam to the vicinity of Grants Pass. The Little Butte Creek small watershed project would provide flood protection on more than 800 acres of the flood plain. Flood damages in the Grants Pass area would be reduced further by development and implementation of a flood plain management plan and 5 miles of levees. Storage of 3,200 acre-feet on Bear Creek would provide recreation opportunity, a water supply for the community of Talent, and drainage of 14,500 acres of cropland, mostly pear orchards.

The Illinois River above Deer Creek and a reach of the Rogue River (Lost Creek damsite to Applegate River) should be studied to determine whether they should be totally or partially preserved in their natural state. Also, fish passage facilities would be installed at existing obstructions where justified.

Continued agency programs and private development would meet remaining projected needs in the fields of land treatment, water conservation, municipal and industrial water supply, water quality, recreation, fish and wildlife, and some of flood control needs. Ten watersheds would be studied to determine those that are suited to help provide these water and land conservation practices. Four of these are in the upper Illinois River drainage, and the other is in Applegate River drainage. These would involve at least eight reservoirs storing about 144,500 acre-feet of water, having about 2,360 acres of surface area, and providing a supplemental irrigation supply for 8,900 acres and a full supply for 33,700 acres. Flood control, drainage, erosion control, and recreation benefits would also accompany the projects.

Umpqua River Subarea (Subregion 10S)

Another scenic and relatively undeveloped drainage is the Umpqua, located north of the Rogue River system. Floods from the Umpqua River cause damages to agricultural lands in the central valley portion of the basin almost every year. Urban areas adjacent to Roseburg, Winston, and Myrtle Creek, and portions of Drain, Sutherlin, and Canyonville also are inundated. Protection on the Umpqua and South Umpqua Rivers could be achieved with upstream storage. Additional flood damage reduction could be provided with 24 miles of levees along the Umpqua River and tributaries and by regulation of developments in the flood plain around Reedsport and Roseburg. Coordination and scheduling of levee construction with upstream storage projects would be necessary.

There are 17,200 acres of irrigated land of which 12,300 have an adequate supply of water. All water is obtained from surface sources. Additional supplies

are necessary to substantially increase the irrigated acreage. Investigations have been made on a 14,500-acre project on Olalla Creek, a 16,000-acre project near Sutherlin on Calapooya Creek, and a 12,300-acre project along the South Umpqua River, all to be supplied by storage. In addition, four small watershed projects with a potential for developing about 30,000 acres of land are being considered for Calapooya Creek, Elk Creek, Myrtle Creek, and Deer Creek.

Adequate quantities of water for municipal purposes are available, but some local problems exist because of low streamflows and inadequate water rights to accommodate future expansion. Some industries are located where water supplies are insufficient and future water supply problems are expected.

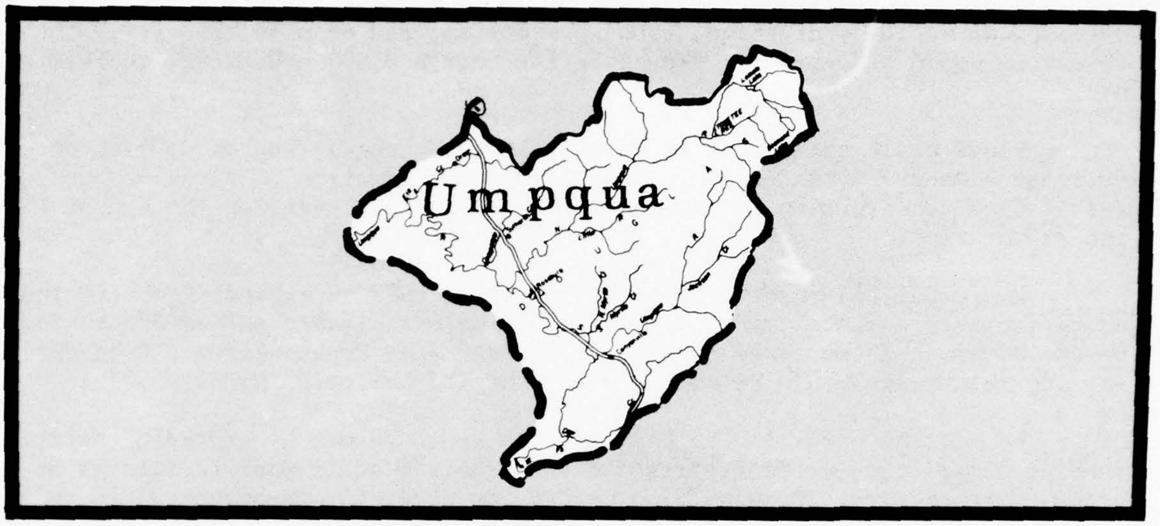
The most serious water quality problem exists on the South Umpqua River where water quality during low flow periods does not meet either dissolved oxygen or temperature requirements for anadromous fish migration. The quality is better in the main river below the confluence with the North Umpqua, but still does not meet the standards for water-contact recreation or the needs of salmonid fish. Minimum average flows need to be provided immediately as treatment facilities do not completely remove all contaminants from waste waters before discharge.

New hydroelectric development in the Umpqua Basin is unlikely. Although there are a number of potential pumped storage and thermonuclear powerplant sites, future electric demands will probably be met by imports.

Fish habitat could be improved by providing passage at numerous manmade and natural barriers. Improved water quality in Deer, Cow, and Elk Creeks would benefit the fish resource. Low flows need to be augmented in Cow Creek, the South Umpqua River below Cow Creek, Elk Creek, Olalla Creek, and the main stem Umpqua River. Westland, and other water areas used extensively by waterfowl, should be protected. Other wildlife habitat improvements needed include more fencing, habitat management, acquisition of land, and development of new water holes.

Major efforts will be necessary to maintain the high quality environment. Scenic roads and trails should be expanded and several streams should be left in their free-flowing state. Widespread zoning is needed to assure that commercial and private developments, both industrial and recreational, are harmonious with the surroundings. Existing primitive, historical, and archeological values should also be preserved.

The primary decision for this basin is whether to include major storage facilities on the Umpqua River and its major tributaries. In this regard, storage on the North Umpqua River or the main stem Umpqua River does not appear necessary to meet needs, nor is it environmentally desirable. Storage on the South Umpqua River however, appears highly desirable and is reflected in the framework plan. Two small watershed projects on Elk and Deer Creeks were alternatives to supply portions of the irrigation recommended for the plan but were rejected because they conflicted with what appeared to be the more environmentally



acceptable and economically justifiable elements selected for the framework plan. Four other watershed projects would be studied to determine their ability to assist in the water and land conservation programs.

Multiple-purpose storage reservoirs are planned for Olalla Creek, Calapooya Creek, Days Creek, Galesville, Rosealea, and Myrtle Creek. The Olalla Project would include a reservoir with a capacity of 73,000 acre-feet of which 37,000 acre-feet would be used jointly for flood control and conservation purposes, including recreation, water to irrigate 14,450 acres, and municipal and industrial supply. Also, in conjunction with the Olalla development would be the enlargement of an existing fish hatchery, flow augmentation in Olalla and Lookingglass Creeks, and rearing of anadromous fish in Olalla Reservoir.

The Calapooya Creek reservoirs could provide nearly 30,000 acre-feet of storage to provide irrigation supplies for 7,500 acres of new land and 1,100 acres of inadequately irrigated land, supply water for municipal, industrial, and domestic use, and assist in flood prevention, drainage, and erosion control.

The Days Creek Reservoir would have an active capacity of about 405,000 acre-feet. The reservoir would provide storage of floodflows and water for irrigation, recreation, municipal, and industrial use, and some streamflow augmentation; a fish hatchery would also be constructued.

The Galesville proposal includes a 75,000 acre-foot reservoir for floodflow storage, irrigation, and flow augmentation. A fish hatchery and passage facilities also would accompany the reservoir development.

The Rosealea development would distribute full or supplemental irrigation supplies from Days Creek or Galesville Reservoirs to 6,900 acres of land. The Myrtle Creek Reservoir, with a capacity of 7,000 acre-feet would be used primarily

for irrigation supplies on approximately 2,800 acres. Associated with irrigation development would be drainage, flood prevention, and erosion benefits. The reservoir would also provide the basis for nearly 2,000 additional recreation-days use.

Flood plain management studies followed by regulation of development would decrease damages in the Roseburg area. Further reduction of flood damages would result from construction of 24 miles of intermittent levees on the Umpqua River and tributaries.

Municipal and industrial water supplies would be expanded to meet the needs for this period. Minimum flows would be established on Cow Creek, South Umpqua River, and the lower reaches of the mainstem Umpqua River. Dredging and logging techniques would be modified to minimize pollution problems.

Recreation needs in the Umpqua Basin would be met by expanding existing camping and picnicking facilities and constructing additional facilities at the proposed reservoirs. Streams recommended for study for preservation in their free-flowing state include the entire North and main stem of the Umpqua River and the mainstem Smith River.

Fort Rock-Christmas Lake-Chewaucan Subarea (Subregion 12)

This portion of the Oregon Closed Basin, Subregion 12, contains five smaller internally drained areas. The three principal streams are: Silver Creek draining into Silver Lake; Ana River, draining into Summer Lake; and Chewaucan River, draining into Lake Abert. Because these lakes have a high alkaline content, water for irrigation, domestic supply, and most recreation must be obtained from natural flow, upstream storage or ground-water development. The ground-water resource is extensive in the Fort Rock-Christmas Lake area.

Occasional spring or winter floods inundate approximately 30,000 acres, and damage fences, roads, irrigation facilities, and buildings in rural places and the urban area of Paisley. Land treatment and watershed measures, water conservation, drainage, erosion and sediment control are needed.

Supplemental forage supply for livestoack, the basin's primary need, would help to stabilize the economy. Winter feed (hay) shortages are the limiting factor in the production cycle. Irrigated pasture is needed to supplement range forage in extremely dry years. Nearly 34,000 acres of irrigated cropland, producing winter feed and supplementary summer pasture, usually are short of irrigation water by July 15 which could be supplied from storage or ground-water development. An estimated 914,000 acres of land are suitable for irrigated cropland if a supply of water could be located. About 27,000 acres of potentially irrigable land could be supplied from storage or ground water in watershed projects and individual development.

Fort Rock, the remnant of an ancient volcanic cone, looms out of the prairie of south central Oregon (Oregon State Highway Commission).

Electrical energy loads are expected to be relatively low and needed energy imported. No problems are anticipated within the next 50 years for municipal or rural-domestic needs for water because of the low projected population expansion. Water quality is not expected to be a major problem; however, minor problems may develop from irrigation return flows and livestock wastes.

The Chewaucan River has the best sport fishery, but trout are found in nearly all perennial streams and fresh water lakes including Thompson Valley and Ana Reservoirs. Measures to insure adequate minimum streamflows are required to protect the resource and artificial propagation of fish may be needed to offset the increased fishing pressure. Mule deer populate the basin in large numbers and a few pronghorn antelope range throughout. The Silver Lake-Fort Rock area is a key winter range for mule deer and upland game birds. Summer Lake Wildlife Management Area is an important waterfowl habitat area and the Silver Lake area is a potential high quality perennial waterfowl area. Extensive environmental values pertain to the wild, undeveloped status and the means to maintain this condition including the preservation of historical, archeological, and ecological resources.

Recreation values are related to remote "open spaces". Water-related activities are not of high quality nor in great demand but the demand could increase if some of the deterring effects were alleviated. Because hiking, hunting, nature walking, pleasure driving, and sightseeing are the most important activities on land, the greatest need is scenic trail and road development.

Irrigation of all potential irrigable cropland appeared undesirable. The Coffeepot site on the Chewaucan River could store water to irrigate land within the Chewaucan Irrigation District and provide flood control benefits at Paisley but was not included in the plan because it is not necessary for meeting allocated needs. Weather modification was also considered but was not included in the plan because of insufficient knowledge about the full impact such a program would have on the environment.

The framework plan proposes storage on Buck Creek and Crooked Creek to provide flood protection on about 18,000 acres of rural land in these watersheds and water for almost 10,000 acres of inadequately irrigated land and 1,000 acres of new land. Three other developments (two providing storage and one utilizing ground water) would provide water for about 15,700 acres of new irrigated land and 18,700 acres of water-short land. An additional 10,300 acres of new land and 1,100 acres of water-short land are expected to be served from ground-water sources by private efforts. Other developments are: drainage of cropland, 15,500 acres; flood protection, about 15,000 acres of rural land and 200 acres of urban land; recreation, over 12,000 recreation-days of use. A flood plain management plan would be initiated to control development in the Paisley area along the Chewaucan River.

Silvies-Silver-Donner und Blitzen Subarea (Subregion 12)

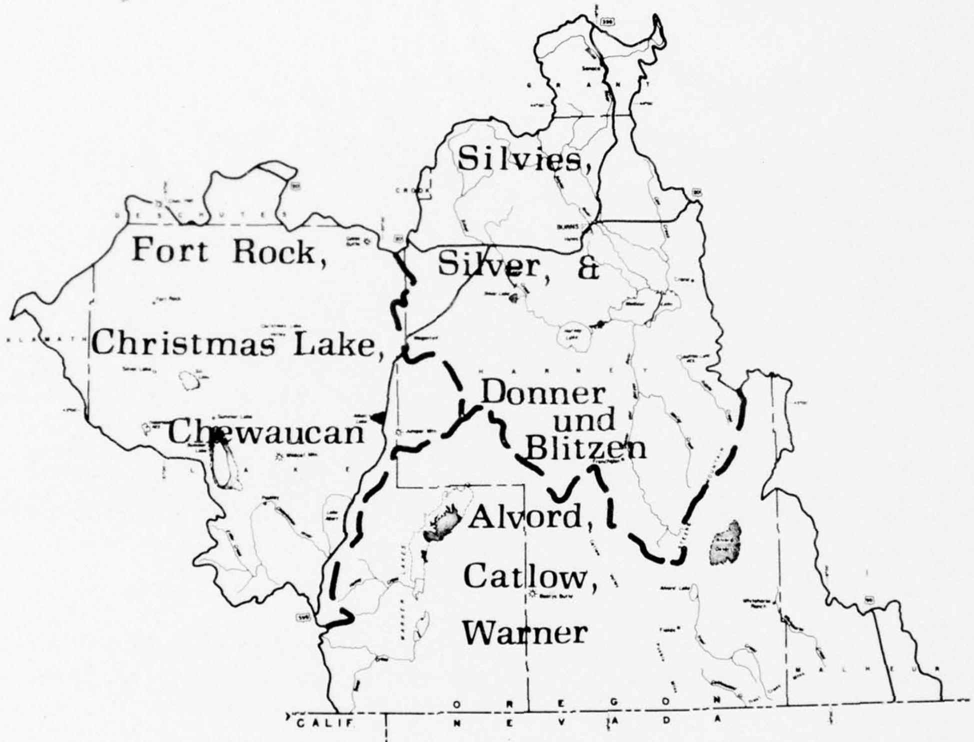
Three drainage systems make up this subarea. The Silvies and Donner und Blitzen Rivers flow into Malheur Lake which overflows into Harney Lake. Silver Creek, the third system, drains directly into Harney Lake. The water in Harney Lake is too alkaline and brackish for almost all uses. The 184,000-acre Malheur National Wildlife Refuge supports an abundance of birds, especially migratory waterfowl and other water birds. The ground water of the basin requires study to establish its potential.

Winter and spring floods inundate about 115,000 acres, damaging fences, roads, irrigation facilities, hay supplies, and buildings in rural areas and the communities of Burns and Hines. Land treatment and watershed protection measures are required in many areas.

Water to produce supplemental forage for the livestock industry is the primary need. Nearly 179,000 acres of irrigated cropland used for summer pasture and to produce winter feed are short of water by mid-July.

Electrical energy loads are expected to be low so energy can be imported. Municipal and rural-domestic water uses amount to about 1.3 mgd each and industrial use is 1.4 mgd. No major waste treatment problems exist and none expected to develop; however, minor problems could develop from irrigation return flows and from livestock waste.

The Malheur National Wildlife Refuge and the Steens Mountain area offer



popular recreation activities such as hiking, rock and gem collecting, sight-seeing, horseback riding, pleasure driving, wildlife observation, and photography. There is a variety of fish and wildlife. Future fishing needs can best be met by maintaining present flows and water quality, by preserving some streams for their present and potential values as fish habitat, and by artificial propagation.

Potential water developments are limited. An alternative to the recommended ground-water development centers around two possible reservoir sites--the Canyon Reservoir on Silvies River and the Bear Creek Reservoir on Bear Creek. Variations utilizing one or both reservoirs to provide anywhere from 24,000 to 120,000 acre-feet of storage for irrigation and flood control have been a subject of controversy because of possible adverse effects upon Malheur Lake and the national wildlife refuge.

Development of surface supply as an alternative for ground water in the

Antelope during the spring in Malheur National Wildlife Refuge in southeast Oregon. Hundreds of different types of birds also make their part-time home in the Refuge (Oregon State Highway Commission).

Willow Creek and Poison Creek Watershed projects is also a possibility; but as these also drain into Malheur Lake such development could also adversely affect the wildlife refuge.

Modification of the weather to control the amount and timing of precipitation was considered as a possibility but not included in the plan because little is known about the full environmental impact of such a program.

The propriety of future water resource development in the basin, particularly the Silvies River, probably will be determined on the basis of the effect on the Malheur National Wildlife Refuge. The framework plan is based on the tentative premises that development of ground water is preferable to surface water and the ground-water resource generally is adequate to meet the area's projected developmental needs. Therefore, the framework plan recommends studies to determine the extent and avilability of ground water, the effects of surface and ground-water withdrawals on wildlife refuge and to further identify alternative methods, programs, projects, and uses of water and related land resources. In the interim Malheur Lake should be maintained esentially in its present condition. The water rights of the *Burns-Paiute Indians must* be considered in all planning for the Silvies Subarea.

The framework plan calls for flood plain zoning ordinances by local governments in Burns and Hines to reduce flood damages by controlling development. Dikes, levees, and channel improvement would provide minimal flood protection on

45,000 acres of rural land and 300 acres of urban area.

Irrigation elements of the plan include development on Willow Creek, Poison Creek, Silver Creek, Upper Silver Creek, and Miller Canyon to supply 7,100 acres of inadequately irrigated land with supplemental water. Storage on Silver Creek could affect a portion of the Malheur National Wildlife Refuge which depends upon this source of water. Development of ground water would insure a full supply of water to 110,000 acres of presently irrigated cropland. Should groundwater sources prove inadequate, the needs would have to be satisfied by alternative means or by development in other subregions.

Drainage of 11,800 acres of cropland and erosion and sediment control on about 100,000 acres of land would be provided. Streams to be considered for preservation for their values as fish habitat are Donner und Blitzen and Silvies Rivers, and Silver and Poison Creeks. Streams recommended for habitat improvement by construction of gabions or sills to stabilize streambeds, create pools and riffles, and maintain channels are Bear, Augur, Bridge, and Elder Creeks. Scenic access roads would be constructed to the Steens Mountain and Aldrich-Strawberry Mountains areas.

Alvord-Catlow-Warner Subarea (Subregion 12)

Three smaller closed basins form this subarea; most streams are intermittent. The exceptions are: Oregon Canyon Creek, flowing into Nevada; Trout Creek, flowing into Alvord Lake; Honey Creek, flowing into Hart Lake; and Twentymile and Deep Creeks, flowing into Crump Lake. Ground water is available in the Oregon Canyon, Alvord Lake, and Warner Lakes areas.

Although runoff from snowmelt and convectional storms flood a maximum of 34,600 acres, damage is usually not significant because of cropping pattern and miminal development in the flood plains. The major flood problem occurs in the Warner lakes area when excessive spring runoff raises the water level in the lakes and inundates the surrounding lowlands. Land treatment and management pracitices are necessary in many areas.

About 79,600 acres of cropland, 75,700 of which are irrigated, produce hay and pasture forage to supplement the almost 4 million acres of rangeland utilized in the livestock enterprise. However, in extremely dry years the forage supply is inadequate for summer as well as winter feed. Approximately 57,000 of acres of irrigated cropland are short of water by mid July. Either additional land must be irrigated or supplemental water supplies provided to the water-short land to alleviate this situation.

Electrical power is expected to be imported from other basins. Municipal and industrial needs for water will continue to be insignificant. No serious waste treatment problems are expected; however, minor water quality problems could develop from irrigation return flows and livestock waste.

Steens Mountain in southeastern Oregon attains a maximum height of 5,000 feet above the expanses of Alvord Valley, itself 4,000 feet above sea level (Oregon State Highway Commission).

Fishing is the major recreational activity on perennial streams. Intensive management including artificial propagation of fish will be necessary to maintain the present and future sport fishery resource. Hunting needs are expected to increase and the esthetic and nonhunting uses of wildlife are expected to increase many times. Where possible, land should be developed and managed in a manner compatible with wildlife production; key game habitat should be preserved; big game winter range must be protected; and watering facilities should be constructed.

The development of the total potential irrigable cropland in four planned watershed projects could be a regional development alternative; however, this alternative was not included in the framework plan. Weather modification was also considered but not included because of insufficient knowledge.

Under the framework plan ground water would supply 8,000 acres of new irrigated land and supplemental water for 18,400 acres of presently irrigated land. Surface supplies primarily from small watershed projects on Trout Creek, Hart Lake, Deep Creek, Whitehorse Creek, and Twentymile Creek would supply 6,000 acres of new irrigation and supplemental water to 27,000 acres.

Land treatment and watershed protection measures would be drainage of cropland, flood prevention, erosion and sediment control, and an estimated 1,300,000 acres of rangeland protection and management. Six watersheds would be studied to determine which can supply part of these measures. Deep, Twelvemile, Honey, and Trout Creeks would be considered for preservation for their present and potential values as fish habitat, and Burnt, Dismal, and Willow Creeks could be improved for trout habitat. Programs to improve big game winter range, including stabilized water conditions and improved livestock grazing distribution, would result in improved wildlife habitat over a large area. Water would be obtained from Honey Creek and overflow from Hart Lake. A multiple-use plan for wildlife management in the north portion of Warner Valley involving 25,000 acres of public land and 37,500 acre-feet of stored water would provide a major increase in waterfowl hunting.

Because the recreational potential is characterized by remoteness, suitable areas with primitive and natural values and "wide-open spaces" should be preserved and access roads and trails should be constructed to these places of interest. Scenic access roads would be constructed to the Warner Lakes and Steens Mountain areas.

AREA D
WESTERN WASHINGTON & LOWER COLUMBIA RIVER
SUBREGIONS 8, 10N, & 11

The Area and Its Needs

This area comprises all of Washington west of the Cascade Mountain Divide and the drainage to the Columbia River in Oregon from St. Helens downstream to just beyond the mouth of the Clatskanie River. The area contains 264 square miles in Oregon and 24,665 square miles of land and water in Washington, exclusive of 2,500 square miles of salt water in Puget Sound and adjacent waters.

The 1970 population of the planning area was 2,611,000 with 86 percent of these people in the Puget Sound Subregion (11). Principal industries include pulp and paper, lumber and other wood products, primary metals, food products, chemical products, and diversified manufacturing. The largest water user is the pulp and paper industry. Slightly less than a third of the employed population work in manufacturing, mostly lumber and wood products and transportation equipment.

The estuarine and coastal waters are currently undergoing development pressures for commercial, residential, and industrial uses, as well as recreation purposes. This usually conflicts with fish and wildlife uses and has a potential for water quality problems. Because the area along the east shore of Puget Sound and adjacent waters is becoming urbanized rapidly, the urban and associated needs, rather than the rural, are important.

Table 16 gives the water and related land resource needs of the area. The locations of subregions are shown on figure 24.

Formulation of Area Framework Plans and Programs

The hundreds of miles of beaches, large estuaries, variety of marine and fresh water life, along with major developments associated with commerce, industry, and water-oriented recreation provide a wide range of possibilities to meet some water and related land needs and only a few alternatives to meet others. The major alternatives considered, the plans or programs evolved, and the reasons for their selections are summarized by subregions.

Lower Columbia Subarea (Subregion 8)

Southwestern Washington and a small adjacent portion of Oregon comprise this subarea. The land, which is 85 percent forested, supports large employment in the pulp and paper and wood processing industries. Although 35 percent

FIGURE 24. Plan Formulation Area D

Table 16—Needs Summary, Area D
Columbia-North Pacific Region

Purpose or Function	Units	Current (1970) Development	Projected Gross Needs 1980	2000	2020	Residual Needs 1980	2000	2020
Water Development and Control								
Electric Power								
Capacity (Peak)	mw			Only Projected on a Regional Basis				
Energy	mil kwh			Only Projected on a Regional Basis				
Navigation								
Commerce	1,000 tons	79,900	112,300	188,500	334,500	32,400	108,600	254,600
Water Quality Control								
Raw Waste Production 1/	1,000 p.e.	24,560	29,358	36,678	44,643	4,798	12,118	20,083
Waste Removal 1/	1,000 p.e.	9,654	21,976	27,285	33,336	12,322	17,631	23,682
Municipal and Industrial Water								
Supply	mgd	1,435	1,981	3,065	4,377	546	1,630	2,942
Municipal	mgd	(349)	(536)	(831)	(1,363)	(187)	(482)	(1,014)
Industrial	mgd	(1,064)	(1,420)	(2,200)	(2,969)	(356)	(1,136)	(1,905)
Rural-domestic	mgd	(22)	(25)	(34)	(45)	(3)	(12)	(23)
Flood Damages								
Major Streams 2/	Ann. $1,000	9,722	-	-	-	14,161	24,397	45,274
Bank Erosion 2/	Ann. $1,000	1,391	-	-	-	1,556	2,061	2,588
Areas Flooded 2/	1,000 ac-ft	405	-	-	-	405	405	405
Irrigation								
Total Irrigated Area	1,000 ac	142	253	317	400	111	175	258
Water Short Area	1,000 ac	(0)	-	-	-	(0)	(0)	(0)
Water Supply	1,000 ac-ft	313	528	655	851	215	342	538
Water and Related Land Programs								
Fish and Wildlife								
Commercial Fishery	1,000 lbs.	162,567	237,257	314,177	410,651	74,690	151,610	248,084
Sport Fishing	1,000 days	9,247	14,792	22,268	33,726	5,545	13,021	24,479
Resident Species	1,000 days	(4,529)	(7,274)	(11,083)	(17,178)	(2,745)	(6,554)	(12,649)
Anadromous, Marine, Shell	1,000 days	(4,718)	(7,518)	(11,185)	(16,548)	(2,800)	(6,467)	(11,830)
Hunting	1,000 days	1,719	2,715	4,101	5,173	996	2,382	3,454
Water Related Recreation								
Development	1,000 rec days	29,100	46,000	102,200	207,100	16,900	73,100	178,000
Required Surface Water Use 3/	acres	186,500	289,100	574,900	1,080,700	102,600	388,400	894,200
Land Area (Rec. Facility Develop.)	acres	6,700	21,100	38,300	72,400	14,400	31,600	65,700
Pleasure Craft	no. (1,000)	214	338	642	1,209	124	428	995
Watershed Management								
Flood Damages—Minor Streams 2/	Ann. $1,000	12,097	-	-	-	16,098	24,013	36,457
Area Flooded 2/	1,000 ac	566	-	-	-	566	566	566
Erosion and Sediment Control	1,000 ac	378	583	952	1,324	205	574	946
Drainage	1,000 ac	335	396	488	565	61	153	230
Beach Erosion Control	miles	-	-	-	-	200	200	200
Bank Stabilization	miles	211	697	1,222	1,730	486	1,011	1,519
Levees and Floodwalls	miles	443	617	879	1,138	174	436	695
Channel Improvement	miles	444	1,481	2,721	3,809	1,037	2,277	3,365
Protection and Management 4/	1,000 ac	12,847	12,850	12,787	12,631	12,762	12,699	12,577
Water Conservation	1,000 ac	122	242	309	390	120	187	268
Water Yield Improvement	1,000 ac	0	6	60	113	6	60	113
Related Land Production								
Croplands	1,000 tons	786	774	973	1,254	-12	187	468
Irrigation	1,000 tons	(213)	(422)	(568)	(998)	(209)	(355)	(785)
Dryland	1,000 tons	(573)	(352)	(405)	(256)	(-221)	(-168)	(-317)
Forest Wood Fiber	mil. cu. ft.	1,431	1,702	2,002	1,956	271	571	525
Range Grazing Capacity	1,000 aum	36	36	37	37	0	1	1

1/ Includes municipal, industrial, and recreation use.
2/ Needs over 1970 level of flood prevention.
3/ Gross needs, existing use of water surface not considered.
4/ *Includes recurrent programs that will require acceleration with implementation of a plan.* Residual needs cannot be determined by subtracting current development from gross needs as many of these practices are applied annually on the same areas.

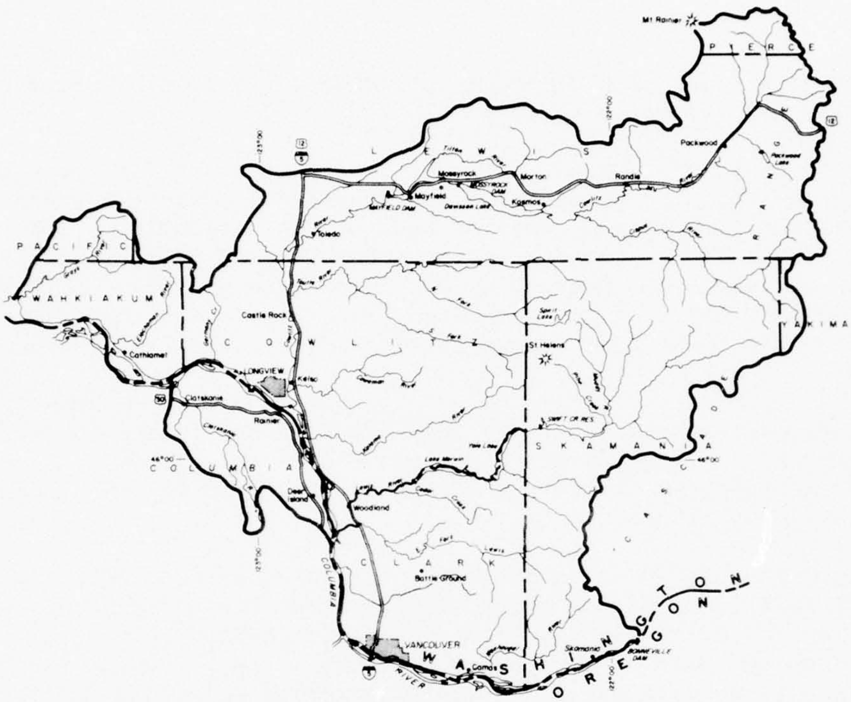
of the subregion (1,116,000 acres) is suitable for crop production, only 201,000 acres are currently so used.

The Columbia flood plain from Portland to the Pacific Ocean comprises much of the existing and potential industrial lands of southwestern Washington and northwestern Oregon, and contains much of the agricultural lands of the subregion. These flood plains comprise about 110,000 acres protected to varying degrees by levees and another 60,000 acres with no local protection works. Approximately one-third of the protected lands need additional drainage facilities and/or levee improvement for full utilization and protection against major floods.

Projected land uses indicate only minor shifts in the forest and rangeland categories, but a major shift of some 85,000 acres from croplands to other lands is expected, primarily for urban expansion in the Vancouver-Camas and Longview-Kelso areas.

All of the 18,000 acres presently irrigated have an adequate water supply. An additional 78,000 acres of irrigated land would be needed by 2020, most of which is expected to be developed in Washington. With ample water supplies and over 200,000 acres of class 1 and 2 land in this subregion, the alternatives are generally a matter of selecting the areas best suited for development.

The Portland-Vancouver area at the confluence of the Willamette with the Columbia River (Delano photo).



More than 87,000 acres of cropland have wetness problems, and it is estimated this will increase to 92,000 acres by 2020. Most wet areas could be drained during the 4 to 5-month growing season.

Municipal and industrial water is supplied from both surface and ground water. Although overall supplies appear adequate, some municipal systems are having problems obtaining sufficient amounts from wells, and storage may be required to satisfy some surface-water needs. Most additional power supply is expected to be contributed by thermal-electric plants. One nuclear plant on which construction was started in 1970 will provide 1,130 MW of capacity. Projections indicate that nearly 12,000 MW of additional thermal-electric generation will be required by 2020. Specific plant sites have not been selected but site selection studies should be undertaken in the near future.

By the mid-1970's, more than 43.5 million acre-feet of joint use storage space will be available on a forecast basis for control of the Columbia River spring floods. With this storage, the 1894 flood stage at Vancouver, Washington, would be reduced from an uncontrolled 34.4 feet to 22.4 feet.

Because of the high level of storage control now provided for the lower Columbia River and general absence of serious damages along major tributary streams in the subarea, major structural flood control measures

Lands and adjacent water areas require careful planning and control to avoid damage to wildlife (BSF&W).

are not contemplated. The projected irrigation acreages are rather small in proportion to the total cropland available and in most cases can be provided water supplies from ground water or streamflow. Water supply sources are generally adequate for municipal, industrial, and other uses. The streams also have sufficient flow to provide for the instream uses, but care must be taken to avoid depletions in headwater areas where flows are vital for fish.

With no major problems in water supply or use, the primary problems and alternatives are associated with the related land. The projected economic growth indicates that lands adjacent to water areas will be desired by several conflicting users. Industry related to waterborne commerce or requiring large amounts of water, water-based recreation, some species of wildlife, and many other elements of the economy and environment require lands directly related to water.

Major alternatives are readily apparent. One is no development to preserve the area for recreation, wildlife habitat, grazing, and other uses that use the natural environment. Another is development directed toward maximizing the economic return which would lean heavily toward industrialization. The most reasonable solution is a mix of the two extremes. This requires a complete land survey directed toward use, cover, and its potential as wildlife habitat, industrial use, port development, etc. Federal, State, county, and municipal governments should undertake such a survey and evalua-

tion to properly regulate and guide future use of the critical water-related land areas.

The framework plan proposes an increase in electric power generating capacity from both thermal and hydro sources. The Trojan nuclear thermal plant will be completed, and the Lewis and Cowlitz River hydro plants would be expanded by 244 megawatts. Thermal powerplants would be constructed with an estimated 11,850 megawatts of capacity. Cooling waters would not be allowed to return to the streams.

The flood damage reduction program along major streams includes controlling flood plain land use by zoning and building codes, new and improved levees, channel rectification, and bank protection along the Cowlitz and Columbia Rivers, and by improved flood forecasting, particularly on the tributary streams. Multiple-purpose operation of the Lewis River power reservoirs for flood control and other uses would also be included.

Irrigation of 35,000 acres of new land is planned in the Brush Prairie area north of Vancouver. The water supply for this development could be diverted from the Lewis River into 150,000 acre-feet of offstream storage, stored on Salmon Creek, diverted from the Columbia River, or pumped from ground water. Three thousand acres of scattered bottom land adjacent to the Columbia River would be irrigated by either ground water or diversion from the Columbia River. Ten thousand acres of irrigation are planned for the lower Lewis River area near Woodland through ground-water development. About 30,000 acres of new lands in the Cowlitz River area would be irrigated from natural flows, ground water, or storage in the upper basin.

Irrigation during the dry summer months promotes optimum plant growth (USBR).

A major dredging program to deepen the Columbia River channel below Vancouver is planned after 1980. Detailed studies are required to determine the exact depth, but an increase of 5 to 10 feet over the existing 40-foot channel, with greater depth at the mouth, is tentatively planned. Land use plans and regulations for disposal areas must be developed as part of the dredging program. Launching ramps and moorage facilities would be expanded and improved to handle the projected increase of approximately 50,000 pleasure boats.

Pollution control would improve the quality of water in Vancouver Lake which has an excellent recreation potential, but is now too polluted to permit water contact recreation.

The fishery resource would be improved by continued programs of habitat preservation and improvement, harvest increased through access improvements, and supplies augmented by hatcheries and rearing ponds.

Reaches of 11 streams should be studied and evaluated for retention as free-flowing streams and for recreation development. Minimum flows should be established on most major streams for fishery needs and for esthetic purposes. Wildlife refuge areas on and near the Columbia River including a whitetail deer refuge, leasing or acquisition of lands, and raising game birds are included in the plan.

Land treatment measures are recommended on 44 watersheds. Included in these and other areas are structural measures and nonstructural programs to reduce erosion, prevent flooding, improve drainage, and conserve and control water. The major effort would be directed toward channel improvement and bank stabilization.

Coastal Zone and Estuaries (Subregions 10N and 11)

The marine shorelands and estuaries of the State of Washington extend from the Columbia River on the south, to the international boundary on the north. Their total length is 2,337 miles including 157 miles facing the open ocean; 252 miles on the estuaries of the Columbia River, Willapa Bay, and Grays Harbor; and 1,928 miles on the waters of Puget Sound, Hood Canal, and the Straits of Juan de Fuca and Georgia, including the shore of 172 significant islands of the San Juan Archipelago. The principal estuaries are those of Puget Sound and adjacent waters, Grays Harbor and Willapa Bay.

Wide sandy beaches backed by dunes and grasslands characterize the coastline from the Columbia River to Quinault, about 72 miles. From the Quinault to Cape Flattery, the shoreline is characterized by narrow rocky beaches with steeply sloping banks. Adjacent lands are heavily forested and numerous rocks dot the ocean surface offshore.

Entrance to Willapa Bay on the Washington coast (USCE).

Along the coastline the 20-fathom depth line runs generally 5 to 10 miles offshore and the 50-fathom line about 15 to 25 miles.

The area behind the beaches from the Columbia River to the Quinault River is heavily developed with motels, summer homes, and permanent residences. From the Quinault River to Cape Flattery the Olympic National Park and five Indian Reservations have limited development, and nearly 90 percent of the coastline remains in a natural or near natural condition.

Grays Harbor, the estuary of the Chehalis River, is located about 45 miles north of the mouth of the Columbia River. The estuary broadens gradually from the river channel at Aberdeen to a wide pear-shaped, shallow estuary about 16-1/2 miles long by 12-1/2 miles wide, and covers an area of 97 square miles at mean lower low tide. The entrance to the ocean is about 2 miles wide and is flanked by jetties which have been in place since the late 19th century.

Willapa Bay is located between Grays Harbor and the Columbia River. It consists of a north-south arm about 19 miles long by 5 miles wide and an east-west arm about 12 miles long tapering from 5 miles wide at Tokeland to a river channel at South Bend. Long Beach Peninsula, the world's longest uninterrupted stretch of sandy beach (28 miles) separates the southern arm of the bay from the ocean. The surface area of the bay ranges from 110 square miles at mean higher high tide to 60 square miles at mean lower low tide. The bay is fed by eight small tributary streams. The entrance to the ocean at the north end is about 6 miles wide with a shifting shoal near the center.

The shores of Grays Harbor and Willapa Bay are largely undeveloped except at Aberdeen, Hoquiam, and Cosmopolis on Grays Harbor, and Raymond and South Bend on Willapa Bay.

It is estimated that 6,300 acres of marsh and tidelands around Willapa Bay have been reclaimed for agriculture and that industrial and highway uses have withdrawn 300 acres. Plans for conversion to pasture lands would withdraw an additional 6,600 acres.

The construction of lagoon-type housing developments has resulted in the draining, clearing, and filling of fresh water swamps and ponds on the bay side of the Long Beach Peninsula. Apart from the effects on wildlife habitat, these activities tend to modify the fresh water regime along the shoreline, and thus affect shellfish production on tidelands. Development limited to the shoreline would be less damaging than one involving tidelands. Tideland development, where combined with the other projects reclaiming the intertidal areas, could reduce the exchange between the estuary and the ocean and affect the biological productivity of the entire estuary. The lands in question have been deeded to private operators for oyster production. Although the proposed use is not in accordance with the original intent, the governmental authority to control the proposed development is limited.

Grays Harbor has been polluted with sulfite waste effluents, phenolics associated with plywood production, and other industrial and municipal wastes. Both Grays Harbor and Willapa Bay have had some degradation by dredging and deposition of spoil.

The shoreline along the Strait of Juan de Fuca is generally a narrow beach backed by steep high bluffs with many outcrops of rock. The depth in the strait generally exceeds 50 fathoms. From Cape Flattery to Port Angeles the shoreline is largely undeveloped except for a few isolated fishing villages.

Puget Sound and adjacent waters, although technically an estuary, is essentially an inland sea with its own network of estuaries, bays, inlets, and passages. It covers an area of 2,500 square miles of almost landlocked salt water with salinity only slightly less than the open ocean. It is one of the deepest salt water basin areas in the United States with depths of 100 to 130 fathoms prevailing in the northern section while south of the Tacoma Narrows 50 fathoms are typical.

Extreme indentations characterize the shoreline, the greater part of which is faced by bluffs ranging from 50 to 500 feet in height, composed of glacial till and material deposited during the past ice age. A narrow beach generally occurs at the base of the bluffs, and water depths exceed 50 to 100 feet close to shore although tidal flats extend for several miles into the sound near several river deltas. Where not cleared away for cities, resorts, or farms, dense coniferous forests grow to the beaches or edges of high bluffs.

Much of the shoreline of the Puget Sound inland waterway is undeveloped because of bluffs and difficulty of access to the beaches. Some portions of the shoreline, however, are developed for industrial, residential, and other urban purposes. The major deep-draft ports in Washington are located on Puget Sound. Residences and summer homes dominate portions of the shorelines of many of the San Juan Islands; Vashon, Bainbridge, and Whidbey Islands; Hood Canal; and the west shore of Puget Sound across from Seattle.

Tides have the diurnal inequality typical of the northern Pacific Coast. The mean diurnal tidal range along the coast is about 8 feet, and the extreme range is about 14 feet. Tides are magnified in all the major estuaries, and extreme tidal ranges are 18 feet in Grays Harbor, 19 feet in Willapa Bay, and as much as 22.5 feet in Puget Sound.

The quality of marine waters including the open waters of Puget Sound is generally good to excellent, although the long-term effects of wastes discharged into the sound are not well known. Localized degradation occurs from municipal and industrial pollution, and the surface layers of several bays and inlets are significantly polluted. Ships in port also contribute to pollution, as do bilge washing and accidental oil spills on open waterways.

The surface waters of some areas of Puget Sound contain concentrations of sulfite waste liquors. These originate primarily from the sulfite pulp mills at Bellingham, Anacortes, Everett, and Port Angeles, Concentrations greater than 10 ppm can be found throughout most of Bellingham Bay, Possession Sound, and Port Angeles Harbor. An ongoing program will insure at least primary treatment of all water discharging into marine waters, including Puget Sound, and secondary treatment of waste discharging into rivers and estuaries.

Sedimentation has been a problem in almost all estuaries with identifiable damage to fish life occurring in Willapa Bay. Caused by erosion in the watershed, silting or sedimentation of waterways and estuaries occurs as a natural phenomenon. However, man's activities, chiefly in land use, contribute to the silt loads of streams and thereby accelerate the silting process in estuaries. On the other hand, the construction of impoundments on the Columbia River tends to reduce sand and silt discharges which sustain coastal features, principally the Long Beach Peninsula, against wave action. Curtailment of the silt may lead to erosion problems.

Relatively minor erosion problems exist in isolated locations within the protected waters of the Puget Sound area. The most serious of these is erosion of the shoreline at Titlow Beach near the city of Tacoma. The bank, about 15 to 20 feet high, has been eroding at the rate of 1 foot per year for many years. The beach and backland are part of a city park, and the city desires to control this erosion so that recreational facilities may be developed.

Esthetic and recreational values of the coastal zone have proven to have strong attractions for man. Existing recreational facilities are

Private ownership of waterfront precludes public use. A program to develop access points will offer the thousands of urban people a place to boat (BOR).

used to capacity during summers, and use at other times is increasing. On many sections of the coast, increasing developmental activity is indicative of the growing demand for vacation homes, trailer parks, marinas, and other facilities. The estuaries have been vital links between ocean commerce and land-bound populations since the beginning of civilization. Cities and industries have developed at convenient transfer points which, in most cases, have been on estuaries. In recent years, the biological importance of the coastal zone and estuaries has been recognized. It is estimated that regions where there is upwelling of deep water containing abundant mineral nutrients, such as occurs off the Washington coast, total not more than one-tenth of 1 percent of the ocean surface, but produce about half of the world's fish supplies. The estuaries also have proven to be prolific food-producing areas making them vital links in the life cycles of many marine and anadromous fish and shellfish.

The entire coastal zone, including the Puget Sound, should be carefully examined from both a physical and biological standpoint in matters of beach erosion; preservation of estuarine areas for fish, shellfish, and wildlife; thermal powerplant siting; port facilities; harbors of refuge for small boats; and adjacent land uses such as recreation facilities, commercial developments, and preservation of unique and scenic sites. The study area should include all beaches, estuaries, and headlands fronting on the Pacific Ocean, plus the San Juan Islands and other islands, Hood Canal, and other straits and inlets of Puget Sound.

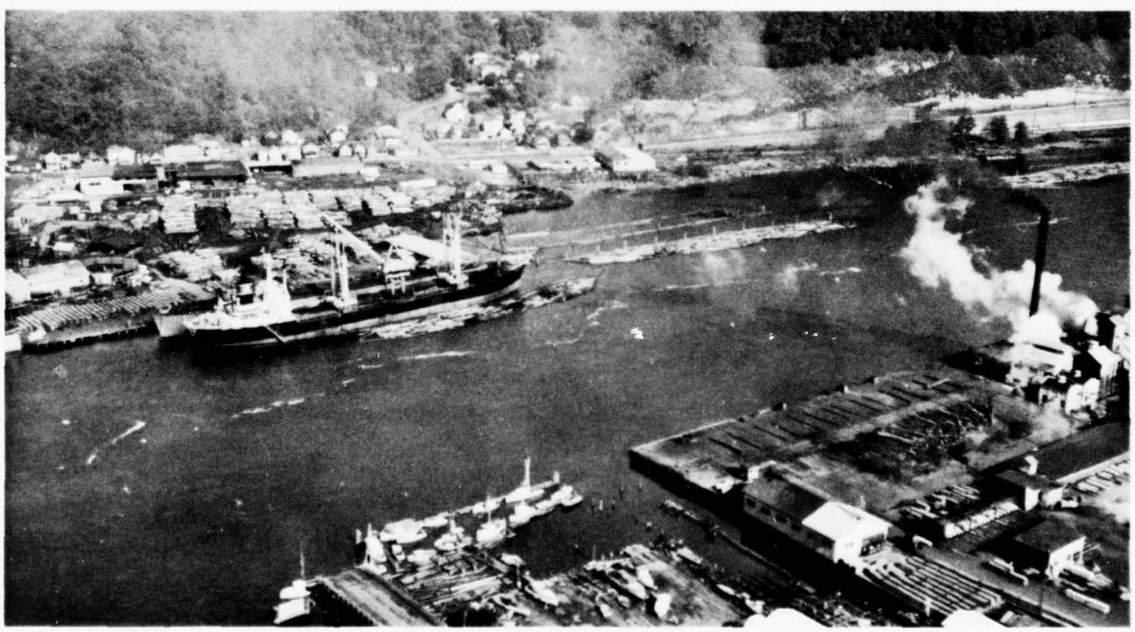
An overall plan for appropriate use of shorelands and of intertidal areas should be developed and implemented. By initiative petition and through legislative action, two measures have been prepared for submission to the voters of the State of Washington. Adoption of either measure would provide for such a master plan and establish the State Department of Ecology as the administering agency.

Washington Coast Subarea (Subregion 10N)

The prosperity of the coastal subregion is closely tied to the extensive forests and the seacoast with their related industries and recreation activities. Large pulp and paper mills in the Aberdeen-Hoquiam area on Grays Harbor are the leading industry and require commercial navigation facilities. Charter boat operations attract large numbers of people and boats to the coast.

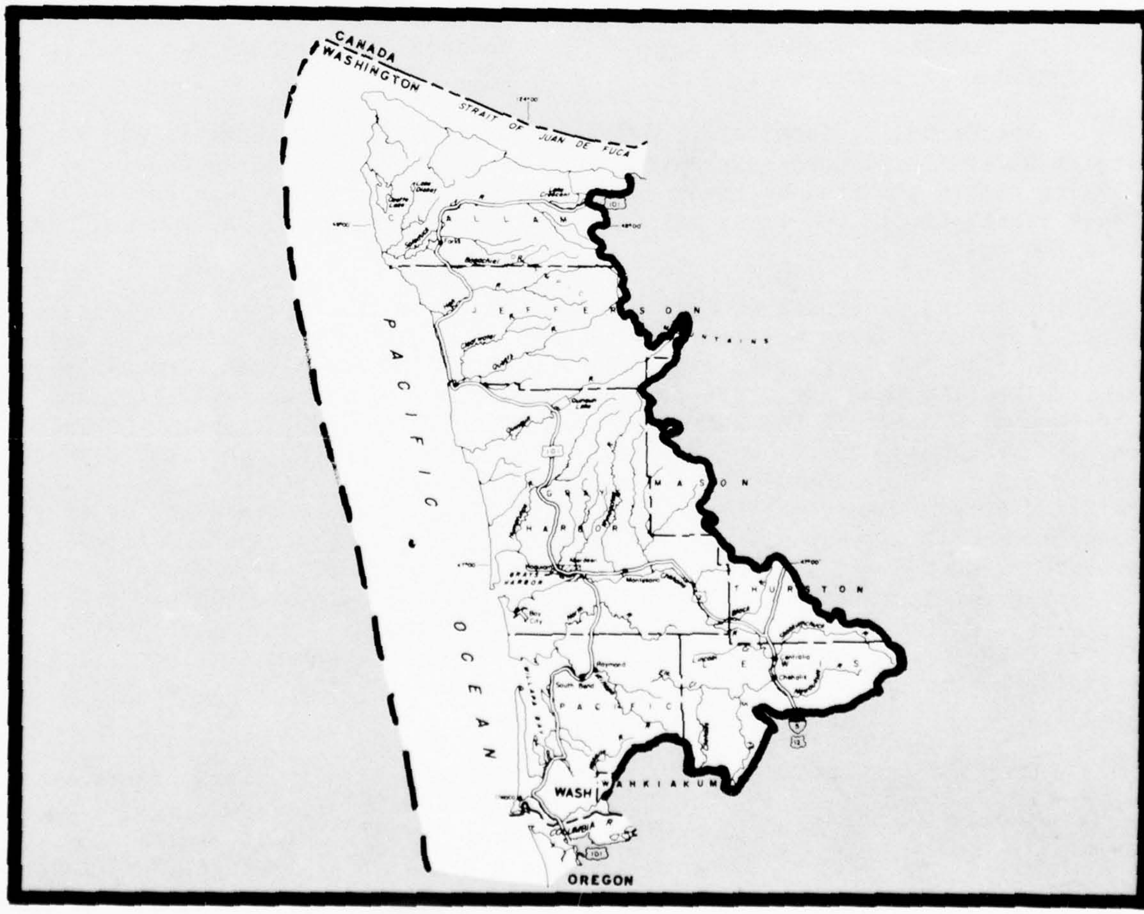
Electric power generation is projected to have major increases during the later years to supply both the coastal area and adjacent populous areas.

Cropland comprises 162,000 acres of which 13,000 acres are irrigated. Much of the nonirrigated cropland could be irrigated, but seasonal low flows will necessitate some storage if surface waters are to be used.



Port facilities at Aberdeen on Grays Harbor (USCE).

Small boat basin at Willapa Bay (USCE).



The land areas of this coastal subregion are subjected to heavy rains which can result in severe erosion and wetness problems. Flood damages occur in the flood plains of the Willapa and Chehalis Rivers and tributaries. Watershed management and protection is needed to combat erosion, prevent flooding, improve drainage, and provide improved land protection and management.

Channel improvements for deep and shallow-draft vessels, breakwaters, and mooring areas and facilities for recreation and fishing boats are required to meet future needs.

The sources for municipal and industrial water supplies are generally adequate, but shortages are developing on the Long Beach Peninsula. Municipalities and industries need to increase the treatment of wastes. Trends indicate that difficulties are approaching on the Long Beach Peninsula between the shellfish industry and waste disposal from the peninsula housing and recreation developments.

The coastal streams are also important for both resident and anadromous fish. There is very little development on these streams and the fish are not subjected to numerous dams or diversions. However, low streamflows need to be augmented in late summer.

The Chehalis, Shoalwater, Quinault, Hoh, Quillayute, Ozette, and Makah Indian Reservations have substantial land areas including the seacoast and fishing rights acquired by treaties at the time the territory was settled. These reservations with their associated treaty rights are a major consideration in planning.

Planning alternatives for this subregion are limited. Environmental aspects dominate large portions of the area and must be given primary consideration. The two large estuaries, Willapa Bay and Grays Harbor, contain plant and marine life that are vital to fish, shellfish, waterfowl, wildlife, and the general economy of the subregion. The excellent clams, crabs, oysters, salmon, steelhead, trout, and bottom fish offer outstanding sport and commercial fishing. The Federal Government, through ownership of the Olympic National Park and National Forest, controls much of the mountain and seashore area north of Grays Harbor. Several Indian Reservations occupy additional areas. About 270 miles of streams have been selected for early study to determine which should be included in the national or a state system of wild and scenic rivers. The projected increase in boating will require about a fivefold increase in launching, mooring, access sites, and other facilities. Swimming, picnicking, and similar activities are projected to increase a like amount.

Complete nondevelopment and full development were rejected as viable alternatives. Nondevelopment would not meet the needs for flood control, food and fiber, and flow augmentation in the interest of water quality and fish habitat. Full development would not be compatible with environmental quality.

The electric power aspects of the framework plan indicate that all of the projected long-range increase in electrical power (9,600 MW), would be from thermal-electric sources. Although individual plant sites have not been selected, most new plants will probably be located on the coastline. The most serious problem facing the planners and developers will be siting of powerplants to avoid environmental conflicts.

Developments on flood plains would be regulated. Levee construction would include 10 miles on the Chehalis River in the Aberdeen-Cosmopolis area, 2 miles on the Willapa River at Raymond, and 9.5 miles in the Chehalis-Centralia area. Damages in the latter area would also be reduced by storage proposed for irrigation, recreation, flow augmentation, and other purposes.

Planned deep-draft navigation improvement includes stabilization of the entrance channel to Willapa Bay and deepening of the entrance channels and some interior waterways in the Columbia River, Willapa Bay, and Grays Harbor estuaries. Additional small boat moorages, launching ramps, and associated facilities would be provided at Grays Harbor, Neah Bay, Sekui, LaPush, and on the lower Columbia River in the vicinity of Ilwaco.

Multiple-purpose storage on the Chehalis River would supply water for 25,000 acres of irrigation, recreation, fish, and flow augmentation downstream. Along the coast, multiple-purpose storage in the Willapa Basin would provide water to irrigate 5,000 acres of new lands in the Raymond-South Bend vicinity. The Willapa storage would also supply additional water for municipal and industrial uses and augment low flows now detrimental to fish. However, the reservoir would inundate a portion of the existing steelhead and salmon spawning grounds.

Ground water would be used to irrigate 31,000 acres, 21,000 in the Chehalis River Basin and 10,000 acres in coastal areas, mostly in the Humptulips Valley. A partial alternative would be to develop 16,000 acres in the Newaukum area of the upper Chehalis Basin which would require about 30,000 to 35,000 acre-feet of storage. Preliminary studies indicated the latter alternative is less favorable from economic and environmental standpoints.

The fish and wildlife programs are oriented toward preservation of habitat and improved access to allow greater harvest of both fresh and salt water fish, upland birds, and big game. Additional fish hatcheries, rearing ponds, stream access improvement, hatching and rearing facilities for game birds, and boat launching lanes are planned. A study would be made of streams to determine which should be preserved in the interest of fish.

The development of over 4,000 acres of recreation land throughout the subarea is planned. Access to lakes and streams would be provided. Also included are studies to investigate reserving some 270 miles of streams as free-flowing, to provide additional wilderness areas, and to designate scenic highways.

Related land programs include a broad range of watershed measures and practices designed to reduce erosion and sedimentation, improve water quality, and alleviate flood and wetness problems. The program calls for studies of 62 watersheds.

Preservation and enhancement of the natural environment should be accomplished by the proper implementation of good land use plans, especially the seacoast management plans, with full recognition given to environmental factors when considering any water or related land development.

Puget Sound Subarea (Subregion 11)

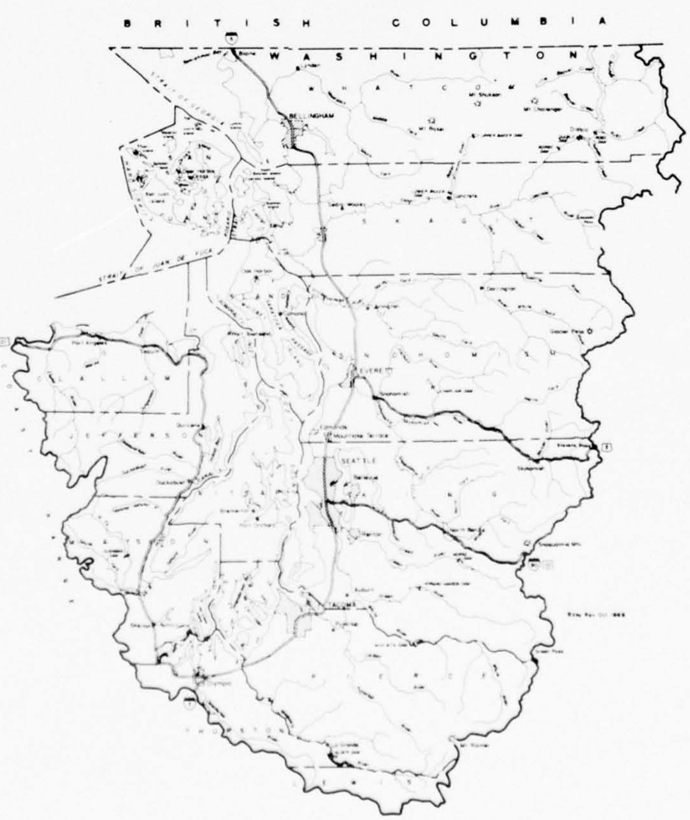
Although the Puget Sound Subarea is the most populous of any in the region, it also contains some of the most secluded and rugged areas. Rugged, forested mountains form a wilderness of great scenic beauty along both the eastern and western boundaries. With over 2 million people concentrated in a rather narrow belt along the east side of the sound, land in the lower valleys and benches is intensively developed and subject to many problems. As usual in populous areas, most employment is in manufacturing, followed by retail trade and professional services. Agriculture, forest management, and fishing total only about 3 percent of the employment.

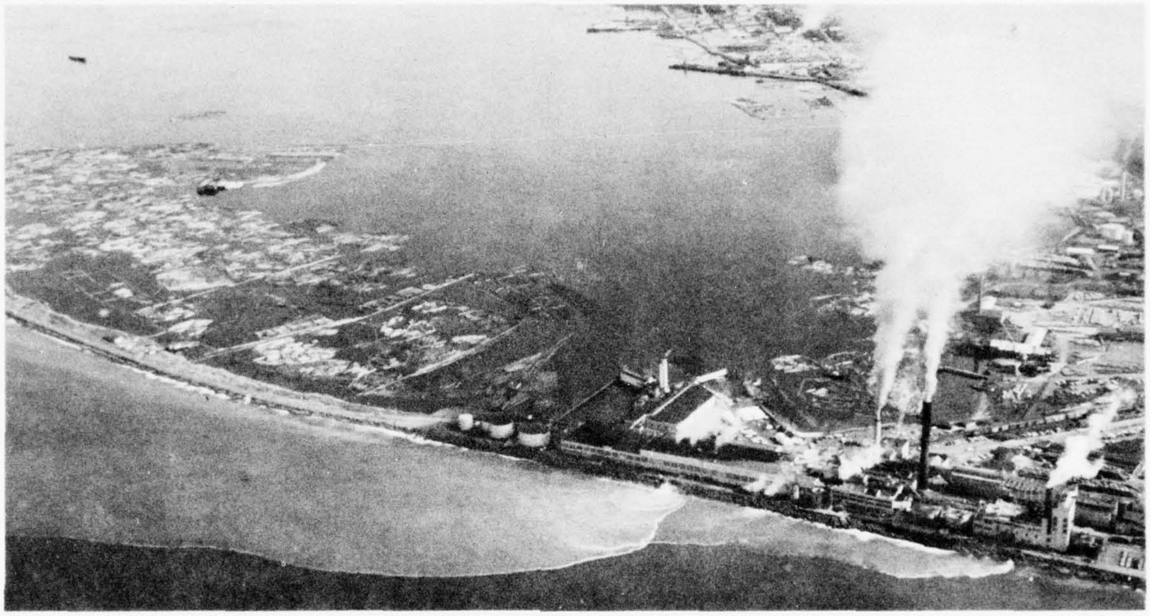
Forests cover 76 percent of the land. The most notable natural feature is the 2,500-square-mile-area of salt water. This large water area, interspersed with wooded islands separated by narrow channels, makes this one of the most delightful water-oriented recreation and boating areas in the world; in fact, Seattle has the highest per capita boat ownership of any city in the United States. This subarea also has 11 Indian Reservations. Although some are quite small, the combined Skokomish, Squaxin Island, Nisqually, Puyallup, Muckleshoot, Port Madison, Port Gamble, Tulalip, Swinomish, Lower Elwha, and Lummi Indian Reservations have substantial land areas and water rights which must be considered in planning for the subregion.

Nine river basins and two island groupings comprise the major part of the Puget Sound tributary drainage. Flooding by overbank flow of main stem streams occurs in all nine basins, with about 87 percent of the damages occurring in the Nooksack, Skagit-Samish, and Snohomish Basins. Only two rivers, the Green and Puyallup, have a level of flood protection to the standard required for urban areas.

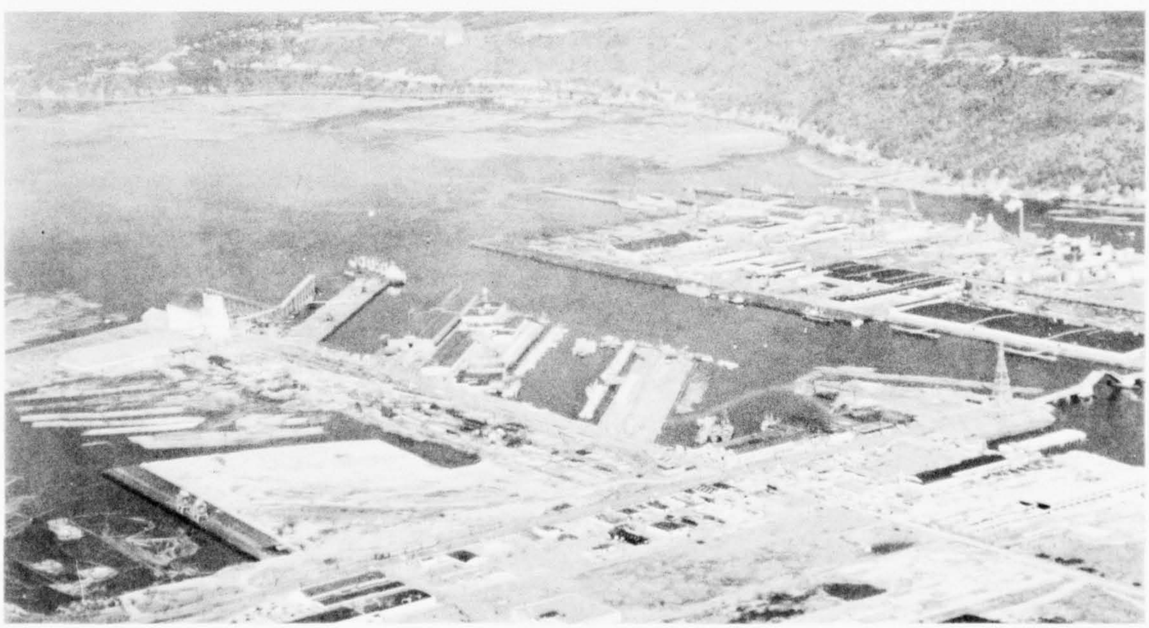
In addition to flooding, this subarea has major land management problems, particularly on the croplands in the upstream areas. More than 747,000 acres are flooded frequently, and over 2 million acres have wetness problems. Nearly all of the land is subject to erosion when not protected. Maintaining the land in productive capacity to meet food and fiber needs will require a coordinated multiple-purpose land and water use program.

Urban land, an increasing important use of the land resources of the Columbia-North Pacific Region (Port of Seattle).





Port Angeles, Washington, 1966 (EPA).



Harbor facilities at Tacoma, Washington (USCE).

Irrigable lands total 516,000 acres, of which 104,000 are presently irrigated. Due to projected urban and industrial expansion onto agricultural lands, only 223,000 acres are projected for irrigation by 2020. Ground-water pumping, upstream storage, and stream diversions would be needed to meet future requirements.

The greatest increase in municipal and industrial water use is expected to occur in the Seattle, Everett, and Tacoma metropolitan areas. Water supplies for the San Juan Islands are extremely critical and are rapidly becoming so for Whidbey and Camano Islands. Expansion of existing distribution facilities and construction of new systems are needed to meet state ratings for health, fire protection, and peak demands.

Wastes causing the degradation of water quality are contributed by municipalities, industries, farms, commercial ships, pleasure craft, and outdoor recreation developments. An estimated 90 percent of the waste discharged into the marine waters in 1968 was untreated industrial waste. Implementation of the (inter- and intra-state) marine and fresh water quality standards is needed for the improvement of water quality.

The port terminal facilities of the basin serve an industrial complex which depends on waterborne commerce to enhance its competitive market position. Significant growth in foreign and domestic commerce is projected with the tonnage forecasted to rise from 42 million tons in 1966 to 252 million tons by 2020. This growth requires additional land and terminal facilities. However, existing undeveloped land suitable for these uses is limited and conversion of higher value land will be required. A regional port study would evaluate land needs and alternative uses. Dredging of channels is also required to provide depths satisfactory to the larger vessels projected for the world fleet.

There are many miles of salt water beaches available for public recreation use if adequate access were provided. Numerous streams, lakes, bays, coves, and harbors provide opportunity for development of swimming, camping, picnicking, and boating facilities. Many streams, or portions thereof, have potential for inclusion into a Federal or State system of wild, scenic, or recreation rivers.

The water rights of the Skokomish, Squaxin Island, Nisqually, Puyallup, Muckleshoot, Port Madison, Port Gamble, Tulalip, Swinomish, Lower Elwha, and Lummi Indian Reservations must be considered in the planning for the Puget Sound Subregion.

The environmental aspects of the area are outstanding and must be preserved. Preservation of free-flowing streams, scenic and historic areas, maintenance and enhancement of water quality, and proper use of shore areas are necessary. Streams flowing into salt water provide excellent habitat for anadromous fish as well as resident species. Nearly every major variety

of anadromous fish plus excellent marine and fresh water fish and shellfish are found throughout the Puget Sound. The sport fishing demands in 2020 are projected to increase about 1-1/2 times over the current level, and the commercial, anadromous, and marine fish and shellfish a similar amount, which will require an increase in the basic resource.

To meet these varied and increasing needs, the planning by the Puget Sound and Adjacent Waters Task Force for the Type 2 study included consideration of all viable alternatives. Numerous upstream storage sites on 20 major rivers and streams were analyzed for flood control, flow augmentation for fish, irrigation and municipal and industrial water supplies, recreation, and power benefits. However, most of the considered sites were rejected because they would involve inundation of areas of high environmental, fish, wildlife, and recreation values or were not justified economically.

The area has only a few sites with potential for economic hydroelectric power development as part of multiple-purpose storage projects. There is, however, good potential for single-purpose pumped storage.

Direct river pumping and treatment, desalinization, diversion, storage, increased ground-water use, and improved water yield through various watershed management practices were considered as means for satisfying water supply needs of municipalities and industry. Although not fully analyzed, desalinization of water was not considered to be economically competitive. Surface and ground-water supplies are adequate in most basins to satisfy irrigation and water supply needs through direct diversion. Interbasin diversions were analyzed in those basins which were expected to have inadequate water supplies.

Alternatives considered for satisfaction of water quality needs were sewage collection and treatment facilities and minimum streamflows adequate for the assimilation of residual wastes after treatment. Other considerations were sewer outfall and dispersal facilities, sludge removal, and waste collection facilities for small boats.

Water supply and water quality are major elements of a study by local governments scheduled for 1971-1973, leading to a master environmental management program for the Lake Washington, Cedar River, and Green-Duwamish River Basins. The studies should develop comprehensive water resources management and water pollution control and abatement plans. Also contemplated are comprehensive plans for air pollution control and abatement, land use allocation, and solid waste management.

Ninety-seven sites along the Puget Sound shoreline are suitable for development as small boat harbors with the capability of mooring more than 115,000 boats. Small boat harbor sites are sufficient to meet public wet moorage needs to the year 2020 in most basins, with some use of moorage opportunities in adjacent basins possible. In the more populated basins, greater

use of dry storage may be required in the long-range period to satisfy total needs.

Considerable opportunity exists for accomplishing a reduction in the growth of flood damages through flood plain zoning and land use management. Management alternatives include flood proofing and warning and evacuation systems. Flood insurance, which serves as an inducement to regulate future development in the flood plain, was also included. Levees, channel improvements, stabilization and drainage facilities, small watershed projects and accompanying management practices, are measures which are required in addition to management of land use to provide adequate flood protection and damage reduction.

Numerous sites with potential for outdoor recreation activity were generally identified, but specific locations were not named.

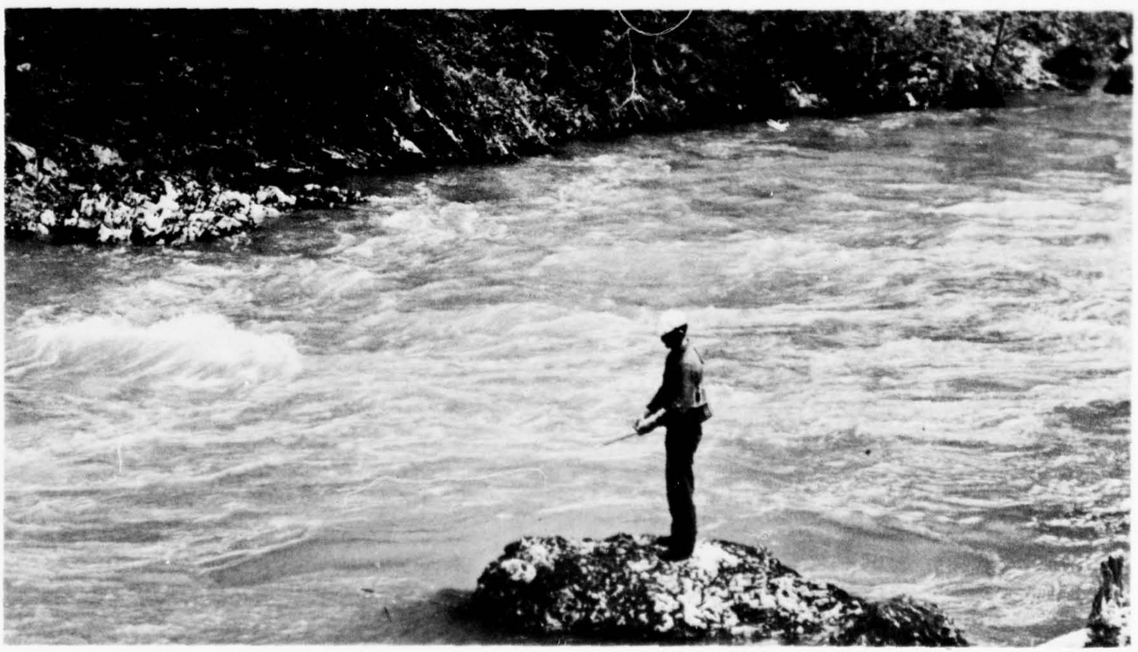
Fish enhancement opportunities included restoration of stream habitat, passage of manmade and natural barriers, and construction of artificial propagation facilities. Wildlife propagation opportunities included bird farms and habitat improvement. Access through easement or acquisition was emphasized as the basic means for increasing sport fishing and hunting opportunities.

Snohomish River—Ebey Slough, November 1959 (USCE).

The Puget Sound and Adjacent Waters (Type 2) Study was completed in 1971, and has been incorporated into the framework plan for the Columbia-North Pacific Study. In most of the river basins, a plan has been prepared that is responsive to the planning objectives. However, in the Skagit and Nisqually River Basins, some competing demands could not be resolved and major development-nondevelopment alternatives were prepared.

In the Skagit-Samish Basins, one alternative allows full use of storage opportunities to obtain maximum flood control in the Skagit River Basin. This alternative assumes that no portion of the Skagit River or its tributaries would be included in the national wild and scenic rivers system as cited in the Wild and Scenic Rivers Act (P.L. 90-452). However, portions of the Skagit River system would be included for study under a state recreational river system.

Another alternative for the Skagit River Basin is based on the assumption that the entire 165-mile river complex cited in the National Wild and Scenic Rivers Act would be designated as part of the national system. The assumption was also made that the entire complex would be given a "Recreational River" classification and that nonstorage developments would be compatible with this classification. Completion of a Federal study now being made under the Act is required before a decision can be made.



Many streams in the Puget Sound area could be given a "Recreation River" classification (Wash. Dept. of Game & Fisheries).

In the Nisqually River Basin, an alternative would allow for retention of the Nisqually Delta in its present relatively natural state and would provide for selective recreation-wildlife and biotic research use of the Nisqually Delta. Another alternative provides for the use of a portion of the delta as a navigation port and related industrial development. A multidiscipline study is recommended to determine which alternative would best meet the short and long-term needs of the area and to resolve questions of compatible use and the desirability of possible joint development.

The framework plan proposes modified and expanded operation of five existing reservoirs and construction of seven new storage projects. The storage would be used for flood control, municipal and industrial water supply, power, irrigation, recreation, and low-flow augmentation in the interest of fish habitat, water quality, and esthetics. Hydroelectric power development would consist of 122 megawatts at proposed multipurpose storage projects and 120 megawatts by expanding an existing project. Additional measures for flood control include flood plain regulations, 147 miles of levees, and 51 miles of channel improvements.

An additional 119,000 acres, located in all basins except San Juan and Whidbey Islands, would be irrigated. The irrigation water supplies for these lands would be obtained from storage and by direct diversion from ground and surface sources. On hundred ten watershed projects would be carried out to provide drainage, erosion control, and flood protection.

Forty-two miles of channel would be dredged in the major ports. Approximately 94 small boat harbor projects would provide about 100,000 moorages, and a study of the Nisqually Delta would be completed. Approximately 40,000 acres, including buffer zones, are expected to be acquired for recreation including salt water beach areas.

Surface water derived from sources in each basin would be the main municipal and industrial supply for eight of the 11 major basins. Whidbey-Camano Islands, Cedar-Green, and Puyallup Basins would need water from adjoining basins. The development of municipal and industrial water supplies by major purveyors and the consolidation of smaller districts into larger regional supply and transmission systems would be required to minimize the possible adverse impacts on the environment and water resources which would occur if every water district developed its own supply.

Waste disposal into the rivers, their tributaries, and salt water would be controlled to meet State and Federal standards. This includes consideration of secondary treatment for plants discharging into certain marine water that currently meet standards with only primary treatment.

Planned trout, steelhead, and salmon propagation facilities include nine new hatcheries and expansion of seven others, spawning channels, and rearing ponds for cutthroat and steelhead. The plan contains artificial

passage facilities across both natural and manmade barriers, stream access, and access sites to fresh and salt water. Stream surveys would be made to determine minimum flows for fish. Fishing piers and jetties located within or near major metropolitan areas are proposed.

Acquisition of 19,700 acres of waterfowl habitat and 3,000 acres of upland bird habitat would enhance hunting opportunities. Big game habitat improvements are scheduled on 10,500 acres of land. Programs for increasing the supply of fish and wildlife, especially those designed to develop new or improved management techniques, are contained in the framework plan. Forty-three rivers are recommended for study as possible scenic, recreation, or wild classification.

REGIONAL FRAMEWORK PLANS AND PROGRAMS

The regional framework plans and programs, obtained from the output of planning for the four areas, are shown by time periods in table 17. A further breakdown by areas and subregions is given in tables 18 through 21. All elements on these tables are in addition (incremental) to developments and programs existing as of December 1969. In 14 river basins or subareas, the complex nature of problems, the wide array of alternatives, or the lack of available data precluded the selection of a plan. In those instances, the specific functional elements in the regional framework constitute a tentative selection.

Framework plans and programs were directed toward meeting needs based on economic projections developed from the March 1968 OBERS data as translated into functional requirements. The environmental objective was given equal consideration with economic efficiency in formulation of plans and programs, and full recognition given to requirements for recreation, fish, wildlife, and preservation of scientific, historic, and esthetic areas. Programs to satisfy environmental objectives include preservation of streams and land, establishment of parkways, scenic roads, and similar items.

The following narrative describes and evaluates each component of the framework plans and programs in the order listed on table 17.

Table 17—Framework Plan Composition, Columbia-North Pacific Region

Purpose or Function	Units	Area A 1970-1980	Area A 1981-2000	Area A 2001-2020	Area A Total	Area B 1970-1980	Area B 1981-2000	Area B 2001-2020	Area B Total
Water Development and Control									
Electric Power									
Hydro	MW	3,195	5,333	0	8,528	1,283	2,309	0	3,592
Thermal	MW	300	2,900	7,000	10,200	0	0	0	0
(consumptive use)	1,000 Ac. Ft.	23	55	117	195	0	0	0	0
Peaking Resources	MW	--	--	--	--	--	--	--	--
Navigation									
Locks	Number	0	3	0	3	1	0	0	1
Channels	Miles	0	57	0	57	32	0	0	32
Breakwaters	Miles	0	0	0	0	0	0	0	0
Water Quality Control									
Raw Waste Production 2/	1,000 PE	2,089	3,332	4,562	9,983	2,105	3,825	3,966	9,896
Waste Removal 2/	1,000 PE	1,640	3,327	4,106	9,073	3,147	3,822	3,569	10,538
M&I Water Supply	MGD	117	217	265	599	108	218	257	583
Municipal	MGD	(52)	(125)	(160)	(337)	(39)	(92)	(109)	(240)
Industrial	MGD	(55)	(75)	(85)	(215)	(55)	(105)	(124)	(284)
Rural-Domestic	MGD	(10)	(17)	(20)	(47)	(14)	(21)	(24)	(59)
Diversions and Withdrawals	1,000 Ac. Ft.	132	241	299	672	120	244	289	653
Flood Control									
Management Areas	Number	73	0	0	73	32	0	0	32
Major Stream Control (channels & levees)	Miles	88	83	15	186	98	26	13	137
Single Purpose Storage	1,000 Ac. Ft.	0	0	0	0	5	0	1	6
Irrigation									
New	1,000 Ac.	847	320	840	2,007	1,085	390	740	2,215
Supplemental	1,000 Ac.	212	99	27	338	273	321	47	641
Diversions and Withdrawals	1,000 Ac. Ft.	3,602	1,508	2,869	7,979	4,460	1,635	2,781	8,876
Multipurpose Reservoir									
Storage Capacity	1,000 Ac. Ft.	875	699	666	2,240	3,669	3,366	154	7,189
Water and Related Land Programs									
Fish									
Habitat Preservation (streams)	Miles	1,890	660	470	3,020	2,810	840	570	4,220
Habitat Improvement:									
Streams	Miles	633	853	841	2,327	4,640	3,278	3,171	11,089
Lakes	1,000 Ac.	34	20	29	83	14	20	20	54
Harvest:									
Stream Access	Miles	1,041	570	796	2,357	603	710	1,018	2,331
Lake Access	Sites	183	93	135	411	73	96	140	309
Saltwater Access	Sites	0	0	0	0	0	0	0	0
Augmentation of Supply									
Hatcheries	Number	5	6	6	17	3	3	2	8
Rearing Ponds	Acres	150	175	175	500	612	1,124	2,161	3,897
Wildlife									
Land Acquisition	1,000 Ac.	548	222	374	1,144	734	402	514	1,650
Habitat Improvement	1,000 Ac.	1,089	1,339	1,725	4,153	833	1,673	1,327	3,833
Improved Hunting Access	1,000 Ac.	6,500	9,100	6,100	21,700	2,435	3,289	2,529	8,253
Augmentation of Supply									
Game Birds	1,000 No.	138	73	111	322	45	40	69	154
Outdoor Recreation (Water Related)									
Recreation Development	1,000 Rec. Days	7,700	20,700	37,000	65,400	8,200	20,600	35,700	64,500
Water Surface Use	Acres	12,900	68,600	125,400	206,900	11,300	40,200	71,700	123,200
Land Area (Rec. Facility Develop.)	Acres	7,000	7,600	17,500	32,100	6,000	8,200	15,500	29,700
Urban Land Acquisition	Acres	2,300	2,100	4,100	8,500	1,600	3,300	5,900	10,800
Boat Launch Areas	No. of lanes	42	422	775	1,239	87	219	453	759
Related Land Programs									
Nonstructural:									
Erosion and Sediment Control	1,000 Ac.	1,485	2,840	2,194	6,519	4,431	6,303	6,091	16,825
Water Conservation	1,000 Ac.	949	315	812	2,076	1,075	364	715	2,154
Protection and Management	1,000 Ac.	26,007	25,941	25,950	NA	30,128	22,529	22,051	NA
Water Yield Improvement	1,000 Ac.	52	95	97	244	39	51	56	146
Structural:									
Drainage	1,000 Ac.	54	89	83	226	123	112	139	374
Trib. Stream Control (Flood Control)									
Bank Stabilization	Miles	1,539	1,819	1,330	4,688	1,272	3,191	2,245	6,708
Dikes and Levees	Miles	154	148	117	419	298	504	590	1,392
Channel Improvement	Miles	2,640	3,309	3,251	9,200	1,949	3,332	2,948	8,229
Erosion Control Structures	Number	3,467	3,831	3,972	11,270	22,200	28,800	23,300	74,300
Ponds and Small Reservoirs	Number	459	839	609	1,907	13,600	15,770	18,230	47,600
	1,000 Ac. Ft.	75	77	37	189	44	82	67	193
Studies									
Coastal Zone and Estuaries:									
Estuarine Management	No.	0	0	0	0	0	0	0	0
Estuarine Management	1,000 Ac.	0	0	0	0	0	0	0	0
Beach Management	Miles	0	0	0	0	0	0	0	0
Beach Stabilization	Miles	0	0	0	0	0	0	0	0
River Basin	No.	6	0	0	6	6	0	0	6
Watersheds	No.	130	110	0	240	151	105	0	256
Special:									
Preservation of Streams	Miles	2,170	0	0	2,170	3,524	0	0	3,524
Scenic Roads	Miles	2,010	0	0	2,010	1,168	0	0	1,168
Roadless Areas	1,000 Ac.	553	0	0	553	1,172	0	0	1,172
Minimum Flows	No.	14	0	0	14	1	0	0	1
Other	No.	9	0	0	9	0	0	0	0

1/ Salt water use data deleted.
2/ Includes municipal, industrial, and recreation use.

Area C 1970-1980	Area C 1981-2000	Area C 2001-2020	Area C Total	Area D 1970-1980	Area D 1981-2000	Area D 2001-2020	Area D Total	Region Total 1970-1980	Region Total 1981-2000	Region Total 2001-2020	Region Total Total
49	1,555	0	1,604	101	545	0	646	4,628	9,742	0	14,370
1,100	22,900	54,000	78,000	2,230	14,370	39,000	55,600	3,630	40,170	100,000	143,800
23	362	759	1,144	46 1/	214 1/	521 1/	781 1/	92	631	1,397	2,120
--	--	--	--	--	--	--	--	300	0	26,300	26,600
1	1	0	2	0	0	0	0	2	4	0	6
36	106	0	142	38	162	5	205	106	325	5	436
2	0	0	2	3	11	0	14	5	11	0	16
1,279	4,345	5,276	10,900	4,798	7,320	7,965	20,083	10,271	18,822	21,769	50,862
1,925	4,476	4,748	11,149	12,322	5,309	6,051	23,682	19,034	16,934	18,474	54,442
281	453	637	1,371	546	1,084	1,312	2,942	1,052	1,972	2,471	5,495
(147)	(253)	(415)	(815)	(187)	(295)	(532)	(1,014)	(425)	(765)	(1,216)	(2,406)
(122)	(182)	(204)	(508)	(356)	(780)	(769)	(1,905)	(588)	(1,142)	(1,182)	(2,912)
(12)	(18)	(18)	(48)	(3)	(9)	(11)	(23)	(39)	(65)	(73)	(177)
315	507	713	1,535	615	1,215	1,476	3,306	1,182	2,207	2,777	6,166
25	0	0	25	18	0	0	18	148	0	0	148
57	296	92	445	190	207	138	535	433	612	258	1,303
6	0	0	6	0	0	0	0	11	0	1	12
566	548	444	1,558	111	64	83	258	2,609	1,322	2,107	6,038
208	247	22	477	0	0	0	0	693	667	96	1,456
2,486	1,708	1,346	5,540	215	127	196	538	10,763	4,978	7,192	22,933
2,763	2,698	1,002	6,463	947	194	50	1,091	8,154	6,957	1,872	16,983
2,670	760	520	3,950	1,750	550	360	2,660	9,120	2,810	1,920	13,850
3,202	6,239	7,747	17,188	490	1,250	1,063	2,803	8,965	11,620	12,822	33,407
33	79	92	204	34	24	23	81	115	143	164	422
793	780	570	2,143	1,367	657	996	3,020	3,804	2,667	3,380	9,851
167	153	118	438	113	54	82	249	536	396	475	1,407
20	25	20	65	77	128	202	407	97	153	222	472
11	13	16	40	15	21	43	79	34	43	67	144
1,000	1,900	1,900	4,800	575	345	775	1,695	2,337	3,544	5,011	10,892
234	238	193	665	137	81	92	310	1,653	943	1,173	3,769
374	507	682	1,563	160	131	253	544	2,456	3,650	3,987	10,093
5,438	7,250	5,438	18,126	3,385	4,515	3,385	11,285	17,758	24,154	17,452	59,364
22	11	16	49	74	32	49	155	279	156	245	680
17,100	34,800	62,100	114,000	16,900	56,200	104,900	178,000	49,900	132,300	239,700	421,900
42,100	85,000	151,000	278,100	102,600	285,800	505,800	894,200	168,900	479,600	853,900	1,502,400
18,100	20,800	42,500	81,400	14,400	17,200	34,100	65,700	45,500	53,800	109,600	208,900
5,300	10,400	22,600	38,300	5,400	11,600	23,300	40,300	14,600	27,400	55,900	97,900
368	1,065	1,919	3,352	213	653	1,142	2,008	710	2,359	4,289	7,358
1,784	2,783	3,212	7,779	205	369	372	946	7,905	12,295	11,869	32,069
544	506	455	1,505	120	67	81	268	2,688	1,252	2,063	6,003
26,847	26,127	27,297	NA	12,762	12,673	11,982	NA	95,744	87,270	87,280	NA
20	32	57	109	6	54	53	113	117	232	263	612
142	186	189	517	61	92	77	230	380	479	488	1,347
1,246	1,498	1,457	4,201	486	525	508	1,519	4,543	7,033	5,540	17,116
477	652	654	1,783	174	262	259	695	1,103	1,566	1,620	4,289
2,807	2,741	2,183	7,731	1,037	1,240	1,088	3,365	8,433	10,622	9,470	28,525
5,148	9,223	6,810	21,181	288	1,034	1,745	3,067	31,103	42,888	35,827	109,818
4,250	6,641	6,021	16,912	660	1,010	1,325	2,995	18,969	24,260	26,185	69,414
36	49	33	118	11	11	9	31	166	219	146	531
22	0	0	22	7	0	0	7	29	0	0	29
57	0	0	57	1,733	0	0	1,733	1,790	0	0	1,790
256	0	0	256	227	122	0	349	483	122	0	605
64	102	0	166	7	91	0	98	71	193	0	264
2	0	0	2	0	0	0	0	14	0	0	14
119	65	0	184	158	58	0	216	558	338	0	896
3,111	0	0	3,111	1,754	0	0	1,754	10,559	0	0	10,559
2,898	0	0	2,898	1,404	0	0	1,404	7,480	0	0	7,480
356	0	0	355	614	0	0	614	2,694	0	0	2,694
1	0	0	1	1	0	0	1	17	0	0	17
6	0	0	6	2	0	0	2	17	0	0	17

Table 18—Framework Plan Composition, Area A

Purpose or Function	Units	Subregion 1 1970-1980	1981-2000	2001-2020	Total
Water Development and Control					
Electric Power					
Hydro	MW	0	800	0	800
Thermal	MW	0	0	0	0
(Consumptive Use)	1,000 Ac. Ft.	0	0	0	0
Navigation					
Locks	Number	0	0	0	0
Channels	Miles	0	0	0	0
Breakwaters	Miles	0	0	0	0
Water Quality Control					
Raw Waste Production 2/	1,000 PE	368	584	699	1,651
Waste Removal 2/	1,000 PE	508	605	629	1,742
Municipal and Industrial Water					
Supply	MGD	61	108	132	301
Municipal	MGD	(29)	(68)	(91)	(188)
Industrial	MGD	(28)	(33)	(33)	(94)
Rural-Domestic	MGD	(4)	(7)	(8)	(19)
Diversions and Withdrawals	1,000 Ac. Ft.	68	122	149	339
Flood Control					
Management Areas	Number	37	0	0	37
Major Stream Control (channels and levees)	Miles	20	5	15	40
Single-Purpose Storage	1,000 Ac. Ft.	0	0	0	0
Irrigation					
New	1,000 Ac.	330	90	370	790
Supplemental	1,000 Ac.	118	50	27	195
Diversions and Withdrawals	1,000 Ac. Ft.	1,032	313	1,130	2,475
Multipurpose Reservoir Storage Capacity	1,000 Ac. Ft.	133	159	16	308
Water and Related Land Programs					
Fish					
Habitat Preservation:					
Streams	Miles	1,300	500	350	2,150
Habitat Improvement:					
Streams	Miles	430	570	550	1,550
Lakes	1,000 Ac.	13	10	13	36
Harvest:					
Stream Access	Miles	139	91	143	373
Lake Access	Sites	44	27	35	106
Augmentation of Supply:					
Hatcheries	Number	1	3	3	7
Rearing Ponds	Acres	0	0	0	0
Wildlife					
Land Acquisition	1,000 Ac.	20	11	24	55
Habitat Improvement	1,000 Ac.	87	126	162	375
Improved Hunting Access	1,000 Ac.	3,000	4,000	2,900	9,900
Augmentation of Supply:					
Game Birds	1,000 No.	10	12	18	40
Outdoor Recreation (water related)					
Recreation Development	1,000 Rec. D.	5,300	10,600	18,600	34,500
Water Surface Use	Acres	8,300	40,500	71,300	120,100
Land Area (Rec. Facility Dev.)	Acres	3,500	3,600	9,000	16,100
Urban Land Acquisition	Acres	1,500	1,500	2,800	5,800
Boat Launch Areas	Lanes	20	230	398	648
Related Land Programs					
Nonstructural					
Erosion and Sediment Control	1,000 Ac.	636	817	682	2,135
Water Conservation	1,000 Ac.	368	92	355	815
Protection and Management	1,000 Ac.	18,275	18,196	18,006	NA
Water Yield Improvement	1,000 Ac.	14	16	15	45
Structural					
Drainage	1,000 Ac.	33	52	47	132
Trib. Stream Control (Flood Control)					
Bank Stabilization	Miles	485	472	443	1,400
Dikes and Levees	Miles	129	131	100	360
Channel Improvement	Miles	1,926	2,433	2,375	6,734
Erosion Control Structures	No.	462	412	440	1,314
Ponds and Small Reservoirs	No.	122	270	190	582
Ponds and Small Reservoirs	1,000 Ac. Ft.	6	3	5	14
Coastal Zone and Estuaries					
Estuarine Management Areas	No.	0	0	0	0
Beach Stabilization	Miles	0	0	0	0
Studies					
River Basin Studies	No.	2	--	--	2
Watersheds	No.	75	50	0	125
Special Studies:					
Preservation of Streams	Miles	1,168	0	0	1,168
Scenic Roads	Miles	560	0	0	560
Roadless Areas	1,000 Ac.	270	0	0	270
Minimal Flows	No.	4	--	--	4
Other	No.	2	--	--	2

1/ Does not include transmittal of 565,000 acre-feet from Subregion 2 to Subregion 6.

2/ Includes municipal, industrial, and recreation uses.

Subregion 2				Subregion 3				Area Total			
1970-1980	1981-2000	2001-2020	Total	1970-1980	1981-2000	2001-2020	Total	1970-1980	1981-2000	2001-2020	Total
3,195	4,523	0	7,718	0	0	0	0	3,195	5,333	0	8,528
300	2,900	7,000	10,200	0	0	0	0	300	2,900	7,000	10,200
23	55	117	195	0	0	0	0	23	55	117	195
0	3	0	3	0	0	0	0	0	3	0	3
0	57	0	57	0	0	0	0	0	57	0	57
0	0	0	0	0	0	0	0	0	0	0	0
1,029	2,098	2,909	6,036	692	650	954	2,296	2,089	3,332	4,562	9,983
559	2,066	2,618	5,253	563	656	859	2,078	1,640	3,327	4,106	9,073
37	74	92	203	19	35	41	95	117	217	265	593
(13)	(37)	(46)	(96)	(10)	(20)	(23)	(53)	(52)	(125)	(160)	(337)
(21)	(30)	(37)	(88)	(6)	(12)	(15)	(33)	(55)	(75)	(85	(215)
(3)	(7)	(9)	(19)	(3)	(3)	(3)	(9)	(10)	(17)	(20)	(47)
42	80	104	226	22	39	46	107	132	241	299	672
23	0	0	23	13	0	0	13	73	0	0	73
7	78	0	85	61	0	0	61	88	83	15	186
0	0	0	0	0	0	0	0	0	0	0	0
476	210	430	1,116	41	20	40	101	847	320	840	2,007
6	31	0	37	88	18	0	106	212	99	27	338
2,326	1,079	1,587	4,992	244	116	152	512	3,602	1,508	2,869 1/	7,979 1/
20	485	560	1,055	722	55	100	877	875	699	666	2,240
190	50	40	280	400	110	80	590	1,890	660	470	3,020
115	138	151	404	88	145	140	373	633	853	841	2,327
19	9	14	42	2	1	2	5	34	20	29	83
545	259	395	1,199	357	170	258	785	1,041	520	796	2,357
122	58	88	268	17	8	12	37	183	93	135	411
3	2	2	7	1	1	1	3	5	6	6	17
100	150	150	400	50	25	25	100	150	175	175	500
276	124	188	588	252	87	162	501	548	222	374	1,144
659	786	974	2,419	343	427	589	1,359	1,089	1,339	1,725	4,153
2,700	4,000	2,500	9,200	800	1,100	700	2,600	6,500	9,100	6,100	21,700
62	30	45	137	66	31	48	145	138	73	111	322
900	6,700	11,800	19,400	1,500	3,400	6,600	11,500	7,700	20,700	37,000	65,400
2,700	16,000	29,700	48,400	1,900	12,100	24,400	38,400	12,900	68,600	125,400	206,900
2,100	2,600	5,400	10,100	1,400	1,400	3,100	5,[illegible]00	7,000	7,800	17,500	32,100
0	0	0	0	800	600	1,300	2,700	2,300	2,100	4,100	8,500
12	103	197	312	10	89	180	279	42	422	775	1,239
631	1,684	1,186	3,501	218	339	326	883	1,485	2,840	2,194	6,519
535	206	418	1,159	46	17	39	102	949	315	812	2,076
8,157	8,185	8,416	NA	1,575	1,560	1,528	NA	26,007	25,941	25,950	NA
16	49	48	113	22	30	34	86	52	95	97	244
10	15	14	39	11	22	22	55	54	89	83	226
1,008	1,232	793	3,033	48	115	94	256	1,539	1,819	1,330	4,688
5	3	3	11	20	14	14	48	154	148	117	419
474	521	546	1,541	240	355	330	925	2,640	3,309	3,251	9,200
879	1,887	2,444	5,210	2,126	1,532	1,088	4,746	3,467	3,831	3,972	11,270
122	266	316	704	215	303	103	621	459	839	609	1,907
67	71	30	168	2	3	2	7	75	77	37	189
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
3	–	–	3	1	–	–	1	6	–	–	6
38	53	0	91	17	7	0	24	130	110	0	240
563	0	0	563	449	0	0	449	2,170	0	0	2,170
1,200	0	0	1,200	250	0	0	250	2,010	0	0	2,010
198	0	0	198	85	0	0	85	563	0	0	563
8	–	–	8	2	–	–	2	14	–	–	14
4	–	–	4	3	–	–	3	9	–	–	9

Table 19—Framework Plan Composition, Area B

Purpose or Function	Units	Subregion 4 1970-1980	1981-2000	2001-2020	Total
Water Development and Control					
Electric Power					
Hydro	MW	0	415	0	415
Thermal	MW	0	0	0	0
(Consumptive Use)	1,000 Ac. Ft.	0	0	0	0
Navigation					
Locks	No.	0	0	0	0
Channels	Miles	0	0	0	0
Breakwaters	Miles	0	C	0	0
Water Quality Control					
Raw Waste Production 2/	1,000 PE	1,413	2,420	2,189	6,022
Waste Removal 2/	1,000 PE	1,908	2,425	1,970	6,303
Municipal and Industrial Water					
Supply	MGD	49	107	133	289
Municipal	MGD	(17)	(38)	(47)	(102)
Industrial	MGD	(26)	(61)	(76)	(163)
Rural-Domestic	MGD	(6)	(8)	(10)	(24)
Diversions and Withdrawals	1,000 Ac. Ft.	55	120	149	324
Flood Control					
Management Areas	No.	8	0	0	8
Major Stream Control (channels and levees)	Miles	52	8	0	60
Single-Purpose Storage	*1,000 Ac. Ft.*	*0*	*0*	*0*	*0*
Irrigation					
New	1,000 Ac.	435	110	180	725
Supplemental	1,000 Ac.	150	175	47	372
Diversions and Withdrawals	1,000 Ac. Ft.	1,875	492	595	2,962
Multipurpose Reservoir Storage Cap.	1,000 Ac. Ft.	46	1,776	0	1,822
Water and Related Land Programs					
Fish					
Habitat Preservation (streams)	Miles	550	160	110	820
Habitat Improvement:					
Streams	Miles	500	550	470	1,520
Lakes	1,000 Ac.	1	6	6	13
Harvest:					
Stream Access	Miles	123	130	153	406
Lake Access Sites	No.	17	27	45	89
Augmentation of Supply:					
Hatcheries	No.	1	0	0	1
Rearing Ponds	Acres	72	74	76	222
Wildlife					
Land Acquisition	1,000 Ac.	186	192	161	539
Habitat Improvement	1,000 Ac.	220	235	260	715
Improved Hunting Access	1,000 Ac.	50	60	76	186
Augmentation of Supply					
Game Birds	1,000 No.	6	13	15	34
Outdoor Recreation (Water Related)					
Recreation Development	1,000 Rec. D	2,900	8,000	14,100	25,000
Water Surface Use	Acres	3,800	15,900	28,600	48,300
Land Area (Rec. Facility Dev.)	Acres	1,700	3,500	6,500	11,700
Urban Land Acquisition	Acres	300	500	800	1,600
Boat Launch Areas	Lanes	17	94	163	274
Related Land Programs					
Nonstructural					
Erosion and Sediment Control	1,000 Ac.	1,923	2,106	1,674	5,703
Water Conservation	*1,000 Ac.*	*432*	*103*	*175*	*710*
Protection and Management	1,000 Ac.	6,058	4,331	4,220	NA
Water Yield Improvement	1,000 Ac.	13	15	13	41
Structural					
Drainage	1,000 Ac.	58	28	37	123
Trib. Stream Cont. (flood control)					
Bank Stabilization	Miles	419	658	643	1,720
Dikes and Levees	Miles	21	44	45	110
Channel Improvement	Miles	673	1,085	906	2,664
Erosion Control Structures	No.	11,200	17,000	14,700	42,900
Ponds and Small Reservoirs	No.	2,500	3,170	3,830	9,500
Ponds and Small Reservoirs	1,000 Ac. Ft.	19	43	19	81
Coastal Zone and Estuaries					
Estuarine Management	1,000 Ac.	0	0	0	0
Beach Management	Miles	0	0	0	0
Beach Stabilization	Miles	0	0	0	0
Studies					
River Basin Studies 1/	No.	3	0	0	3
Watersheds	No.	58	41	0	99
Special Studies:					
Preservation of Streams	Miles	928	0	0	928
Scenic Roads	Miles	374	0	0	374
Roadless Areas	1,000 Ac.	716	0	0	716
Minimum Flows	No.	--	-	--	--
Other					

1/ None included for Idaho on instructions from IWRB by letter dated 10-4-71.
2/ Includes municipal, industrial, and recreation uses.

Subregion 5				Subregion 6				Area Total			
1970-1980	1981-2000	2001-2020	Total	1970-1980	1981-2000	2001-2020	Total	1970-1980	1981-2000	2001-2020	Total
545	424	0	969	738	1,470	0	2,208	1,283	2,309	0	3,592
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	1	1	0	0	1
0	0	0	0	32	0	0	32	32	0	0	32
0	0	0	0	0	0	0	0	0	0	0	0
558	1,186	1,536	3,279	134	219	242	595	2,105	3,825	3,966	9,896
811	1,158	1,381	3,350	428	239	218	885	3,147	3,822	3,569	10,538
40	81	96	216	19	30	29	78	108	218	257	583
(14)	(38)	(45)	(97)	(8)	(16)	(17)	(41)	(39)	(92)	(109)	(240)
(20)	(35)	(40)	(95)	(9)	(9)	(8)	(26)	(55)	(106)	(124)	(284)
(6)	(8)	(10)	(24)	(2)	(5)	(4)	(11)	(14)	(21)	(24)	(59)
45	90	107	242	20	34	33	87	120	244	289	653
9	0	0	9	15	0	0	15	32	0	0	32
34	6	13	53	12	12	0	24	98	26	13	137
5	0	1	6	0	0	0	0	5	0	1	6
486	170	340	996	164	110	220	494	1,085	390	740	2,215
72	70	0	142	51	76	0	127	273	321	47	641
1,951	711	1,360	4,022	634	432	826	1,892	4,460	1,635	2,781	8,876
3,074	1,252	3	4,329	549	338	151	1,038	3,669	3,366	154	7,189
600	180	130	910	1,660	500	330	2,490	2,810	840	570	4,220
3,000	2,000	2,000	7,000	1,140	728	701	2,569	4,640	3,278	3,171	11,089
12	13	13	38	1	1	1	3	14	20	20	54
120	170	115	405	360	410	750	1,520	603	710	1,018	2,331
20	45	60	125	36	24	35	95	73	96	140	309
1	2	2	5	1	1	0	2	3	3	2	8
0	0	0	0	540	1,050	2,085	3,675	612	1,124	2,161	3,897
214	162	123	499	334	48	230	612	734	402	514	1,650
489	1,290	876	2,655	124	148	191	463	833	1,673	1,327	3,833
1,011	1,383	1,045	3,439	1,374	1,846	1,408	4,628	2,435	3,289	2,529	8,253
1	2	3	6	38	25	51	114	45	40	69	154
3,900	9,000	14,800	27,700	1,400	3,600	6,800	11,800	8,200	20,600	35,700	64,500
6,200	17,800	31,100	55,100	1,300	6,500	12,000	19,800	11,300	40,200	71,700	123,200
3,700	3,800	6,400	13,900	600	900	2,600	4,100	6,000	8,200	15,500	29,700
1,300	2,400	3,900	7,600	0	400	1,200	1,600	1,600	3,300	5,900	10,800
45	75	200	320	25	50	90	165	87	219	453	759
1,771	3,034	3,189	7,994	737	1,163	1,228	3,128	4,431	6,303	6,091	16,825
479	162	327	968	164	99	213	476	1,075	364	715	2,154
10,535	4,724	4,415	NA	13,535	13,474	13,416	NA	30,128	22,529	22,051	NA
12	17	17	46	14	19	26	59	39	51	56	146
49	62	81	192	16	22	21	59	123	112	139	374
457	2,170	1,458	4,085	396	363	144	903	1,272	3,191	2,245	6,708
264	443	529	1,236	13	17	16	46	298	504	590	1,392
700	1,475	1,717	3,892	576	772	325	1,673	1,949	3,332	2,948	8,229
10,500	11,300	8,100	29,900	500	500	500	1,500	22,200	28,800	23,300	74,300
9,400	9,400	10,100	28,900	1,700	3,200	4,300	9,200	13,600	15,770	18,230	47,600
23	33	40	96	2	6	8	16	44	82	67	193
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	2	1	0	0	1	6	0	0	6
48	47	0	95	45	17	0	62	151	105	0	256
953	0	0	953	1,643	0	0	1,643	3,524	0	0	3,524
334	0	0	334	460	0	0	460	1,168	0	0	1,168
73	0	0	73	383	0	0	383	1,172	0	0	1,172
–	–	–	–	–	–	–	–	1	0	0	1

Table 20—Framework Plan Composition, Area C

Purpose or Function	Units	Subregion 7 1970-1980	Subregion 7 1981-2000	Subregion 7 2001-2020	Subregion 7 Total	Subregion 9 1/ 1970-1980	Subregion 9 1/ 1981-2000	Subregion 9 1/ 2001-2020	Subregion 9 1/ Total
Water Development and Control									
Electric Power									
Hydro	MW	0	1,480	0	1,480	0	75	0	75
Thermal	MW	1,100	13,900	25,000	40,000	0	5,000	19,000	24,000
Consumptive use	1,000 Ac. Ft.	23	264	437	724	0	97	319	416
Navigation									
Locks	Number	1	0	0	1	0	1	0	1
Channels	Miles	0	0	0	0	0	106	0	106
Breakwaters	Miles	0	0	0	0	0	0	0	0
Water Quality Control									
Raw Waste Production 2/	1,000 PE	594	820	1,071	2,485	67	2,796	3,474	6,203
Waste Removal 2/	1,000 PE	645	854	964	2,463	74	2,831	3,126	5,883
M&I Water Supply	MGD	34	48	55	137	164	309	517	990
Municipal	MGD	(8)	(24)	(22)	(54)	(127)	(202)	(357)	(686)
Industrial	MGD	(22)	(16)	(26)	(64)	(32)	(101)	(152)	(285)
Rural-Domestic	MGD	(4)	(8)	(7)	(19)	(5)	(6)	(8)	(19)
Diversions and Withdrawals	1,000 Ac. Ft.	38	53	62	153	183	348	578	1,109
Flood Control									
Management Areas	Number	6	0	0	6	9	0	0	9
Major Stream Control									
(channels and levees)	Miles	4	29	17	50	52	149	75	276
Single-Purpose Storage	1,000 Ac. Ft.	6	0	0	6	0	0	0	0
Irrigation									
New	1,000 Ac.	307	90	272	669	186	420	150	756
Supplemental	1,000 Ac.	95	128	14	237	26	0	0	26
Diversions and Withdrawals	1,000 Ac. Ft.	1,537	410	1,006	2,953	589	1,034	268	1,891
Multipurpose Reservoir									
Storage Capacity	1,000 Ac. Ft.	958	502	272	1,732	933	1,282	701	2,916
Water and Related Land Programs									
Fish									
Habitat Preservation Streams	Miles	800	200	150	1,150	600	180	120	900
Habitat Improvement:									
Streams	Miles	718	1,532	2,232	4,482	810	1,050	860	2,720
Lakes	1,000 Ac.	13	32	46	91	10	11	11	32
Harvest									
Stream Access	Miles	330	250	238	818	130	150	95	375
Lake Access	Sites	77	46	33	156	30	25	25	80
Saltwater Access	Sites	0	0	0	0	0	0	0	0
Augmentation of Supply									
Hatcheries 3/	Number	5	4	7	16	2	0	4	6
Rearing Ponds	Acres	100	125	150	375	800	1,600	1,600	4,000
Wildlife									
Land Acquisition	1,000 Ac.	181	162	157	500	18	9	15	42
Habitat Improvement	1,000 Ac.	216	357	427	1,000	42	33	20	95
Improved Hunting Access	1,000 Ac.	2,350	3,134	2,350	7,834	1,045	1,393	1,045	3,483
Augmentation of Supply									
Game Birds	1,000 No.	22	11	16	49	0	0	0	0
Outdoor Recreation (Water Related)									
Recreation Development	1,000 R. Days	2,900	7,500	13,300	23,700	9,200	13,200	23,900	46,300
Water Surface Use	Acres	3,400	14,900	26,100	44,400	29,000	41,000	73,000	143,000
Land Area (Rec. Facility Develop.)	Acres	1,200	2,800	6,000	10,000	12,300	12,000	24,600	48,900
Urban Land Acquisition	Acres	0	0	1,000	1,000	5,300	7,400	14,600	27,300
Boat Launch Areas	No. of Lanes	10	85	170	265	293	810	1,439	2,542
Related Land Programs									
Nonstructural									
Erosion and Sediment Control	1,000 Acres	1,168	1,819	2,280	5,267	127	202	197	526
Water Conservation	1,000 Acres	310	90	282	682	173	407	146	726
Protection & Management	1,000 Acres	9,180	9,103	8,313	NA	5,228	5,061	5,092	NA
Water Yield Improvement	1,000 Acres	16	24	49	89	2	4	5	11
Structural									
Drainage	1,000 Acres	8	16	16	40	84	105	106	295
Trib. Stream Control (flood control)									
Bank Stabilization	Miles	484	690	720	1,894	208	80	79	367
Dikes and Levees	Miles	148	205	202	555	16	21	21	58
Channel Improvement	Miles	639	765	729	2,133	420	196	192	808
Erosion Control Structures	No.	3,286	6,040	2,125	11,451	2	3	2	7
Ponds and Small Reservoirs	No.	1,731	1,690	2,130	5,551	774	1,807	607	3,188
	1,000 Ac. Ft.	4	9	8	21	5	11	6	22
Studies									
Coastal Zone and Estuaries									
Estuarine Management	No.	--	--	--	--	--	--	--	--
Estuarine Management	1,000 Acres	--	--	--	--	--	--	--	--
Beach Management	Miles	--	--	--	--	--	--	--	--
Beach Stabilization	Miles	--	--	--	--	--	--	--	--
River Basin	No.	--	--	--	--	--	--	--	--
Watersheds	No.	38	29	0	67	49	23	0	72
Special:									
Preservation of Streams	Miles	874	0	0	874	1,250	0	0	1,250
Scenic Roads	Miles	1,008	0	0	1,008	398	0	0	398
Roadless Areas	1,000 Acres	0	0	0	0	5	0	0	5
Minimum Flows	No.								
Other	No.								

1/ Data from Willamette Basin Type 2 Study or based upon basic Type 2 data adjusted to C-NP definitions and assumptions.

2/ Includes municipal, industrial, and recreation uses.

3/ Does not include hatcheries required as mitigation features of reservoir projects.

Subregion 10s				Subregion 12				Area Total			
1970-1980	1981-2000	2001-2020	Total	1970-1980	1981-2000	2001-2020	Total	1970-1980	1981-2000	2001-2020	Total
49	0	0	49	0	0	0	0	49	1,555	0	1,604
0	4,000	10,000	14,000	0	0	0	0	1,100	22,900	54,000	78,000
0	1	2	3	0	0	0	0	23	362	759	1,144
0	0	0	0	0	0	0	0	1	1	0	2
36	0	0	36	0	0	0	0	36	106	0	142
2	0	0	2	0	0	0	0	2	0	0	2
747	718	712	2,177	5	11	19	35	1,279	4,345	5,276	10,900
1,352	779	641	2,772	2	12	17	31	1,925	4,476	4,748	11,149
81	94	62	237	2	2	3	7	281	453	637	1,371
(11)	(27)	(34)	(72)	(1)	(0)	(2)	(3)	(147)	(253)	(415)	(815)
(68)	(64)	(26)	(158)	(0)	(1)	(0)	(1	(122)	(182)	(204)	(508)
(2)	(3)	(2)	(7)	(1)	(1)	(1)	(3	(12)	(18)	(18)	(48)
91	105	69	265	3	1	4	8	315	507	713	1,535
8	0	0	8	2	0	0	2	25	0	0	25
1	118	0	119	0	0	0	0	57	296	92	445
0	0	0	0	0	0	0	0	6	0	0	6
66	4	22	92	7	34	0	41	566	548	444	1,558
10	0	8	18	77	119	0	196	208	247	22	477
244	8	72	324	116	256	0	372	2,486	1,708	1,346	5,540
858	803	29	1,690	14	111	0	125	2,763	2,698	1,002	6,463
1,000	300	200	1,500	270	80	50	400	2,670	760	520	3,950
776	2,511	3,515	6,802	898	1,146	1,140	3,184	3,202	6,239	7,747	17,188
8	33	32	73	2	3	3	8	33	79	92	204
315	360	225	900	18	20	12	50	793	780	570	2,143
50	66	50	166	10	16	10	36	167	153	118	438
20	25	20	65	0	0	0	0	20	25	20	65
4	9	5	18	0	0	0	0	11	13	16	40
100	175	150	425	0	0	0	0	1,000	1,900	1,900	4,800
16	21	14	51	19	46	7	72	234	238	193	665
43	68	170	281	73	49	65	187	374	507	682	1,563
1,531	2,041	1,531	5,103	512	682	512	1,706	5,438	7,250	5,438	18,126
0	0	0	0	0	0	0	0	22	11	16	49
4,600	13,400	23,700	41,700	400	700	1,200	2,300	17,100	34,800	62,100	114,000
9,300	28,100	50,200	87,600	400	1,000	1,700	3,100	42,100	85,000	151,000	278,100
4,500	5,900	11,700	22,100	100	100	200	400	18,100	20,800	42,500	81,400
0	3,000	6,900	9,900	0	0	100	100	5,300	10,400	22,600	38,300
60	165	300	525	5	5	10	20	368	1,065	1,919	3,352
178	302	295	775	311	460	440	1,211	1,784	2,783	3,212	7,779
54	6	21	81	7	3	6	16	544	506	455	1,505
10,140	10,115	10,081	NA	2,299	1,848	1,811	NA	26,847	26,127	25,297	NA
1	2	1	4	1	2	2	5	20	32	57	109
34	43	45	122	16	22	22	60	142	186	189	517
404	503	431	1,335	150	228	227	605	1,246	1,498	1,457	4,201
220	294	296	810	93	132	135	360	477	652	654	1,783
1,614	1,576	1,052	4,242	134	204	210	548	2,807	2,741	2,183	7,731
545	2,134	-3,446	6,125	1,315	1,046	1,237	3,598	5,148	9,223	6,810	21,181
104	436	569	1,109	1,641	2,708	2,715	7,064	4,250	6,641	6,021	16,912
2	2	2	6	25	27	17	69	36	49	33	118
22	--		22	--	--	--	--	22	--	--	22
57	--	--	57	--	--	--	--	57	--	--	57
256	--	--	256	--	--	--	--	256	--	--	256
64	102	--	166	--	--	--	--	64	102	--	166
--	--	--	--	1	--	--	1	1	--	--	1
20	9	0	29	12	4	0	16	119	65	0	184
987	0	0	987	0	0	0	0	3,111	0	0	3,111
840	0	0	840	652	0	0	652	2,898	0	0	2,898
119	0	0	119	231	0	0	231	355	0	0	355
								1	--	--	1
								6	--	--	6

Table 21—Framework Plan Composition, Area D

Purpose or Function	Units	Subregion 8 1970-1980	1981-2000	2001-2020	Total
Water Development and Control					
Electric Power					
Hydro	MW	41	303	0	344
Thermal	MW	1,130	5,870	6,000	13,000
(Consumptive Use)	1,000 Ac. Ft.	23	78	103	204
Navigation					
Locks	Number	0	0	0	0
Channels	Miles	0	118	0	118
Breakwaters	Miles	0	0	0	0
Water Quality Control					
Raw Waste Production 1/	1,000 PE	1,007	2,297	894	4,198
Waste Removal 1/	1,000 PE	2,652	2,314	805	5,771
Municipal and Industrial Water					
Supply	MGD	123	246	142	511
Municipal	MGD	(14)	(23)	(30)	(67)
Industrial	MGD	(109)	(221)	(111)	(441)
Rural-Domestic	MGD	(0)	(2)	(1)	(3)
Diversions and Withdrawals	1,000 Ac. Ft.	139	274	160	573
Flood Control					
Management Areas	Number	6	0	0	6
Major Stream Control (channels and levees)	Miles	61	130	124	315
Single-Purpose Storage	1,000 Ac. Ft.	0	0	0	0
Irrigation					
New	1,000 Ac.	38	10	30	78
Supplemental	1,000 Ac.	0	0	0	0
Diversions and Withdrawals	1,000 Ac. Ft.	94	22	81	197
Multipurpose Reservoir Storage					
Capacity	1,000 Ac. Ft.	150	0	35	185
Water and Related Land Programs					
Fish and Wildlife					
Fish:					
Habitat Preservation (streams)	Miles	500	150	100	750
Habitat Improvement:					
Streams	Miles	175	585	583	1,343
Lakes	1,000 Ac.	8	11	3	22
Harvest:					
Stream Access	Miles	309	152	226	687
Lake Access Sites	Number	17	8	12	37
Saltwater Area Sites	Number	0	0	0	0
Augmentation of Supply:					
Hatcheries	Number	4	2	3	9
Rearing Ponds	Acres	175	75	75	325
Wildlife:					
Land Acquisition	1,000 Ac.	30	17	21	68
Habitat Improvement	1,000 Ac.	31	45	51	127
Improved Hunting Areas	1,000 Ac.	852	1,137	852	2,841
Augmentation of Supply:					
Game Birds (1,000's)	Number	12	6	9	27
Outdoor Recreation (Water Related)					
Recreation Development	1,000 Rec. Days	1,500	2,800	4,800	9,100
Water Surface Use	Acres	11,100	22,600	40,300	74,000
Land Area (rec. facility dev.)	Acres	1,000	1,500	2,800	5,300
Urban Land Acquisition	Acres	200	600	1,400	2,200
Boat Launch Areas	Lanes	98	193	342	633
Related Land Programs					
Nonstructural:					
Erosion and Sediment Control	1,000 Ac.	39	72	70	181
Water Conservation	1,000 Ac.	37	12	32	81
Protection and Management	1,000 Ac.	2,659	2,654	2,123	NA
Water Yield Improvement	1,000 Ac.	0	0	0	0
Structural:					
Drainage	1,000 Ac.	22	18	22	62
Trib. Stream Control (flood cont.):					
Bank Stabilization	Miles	181	220	225	626
Dikes and Levees	Miles	7	35	30	72
Channel Improvement	Miles	163	259	276	698
Erosion Control Structures	Number	19	15	15	49
Ponds and Small Reservoirs	Number	1	1	4	6
Ponds and Small Reservoirs	1,000 Ac. Ft.	6	6	3	15
Studies					
Coastal Zone and Estuaries					
Estuarine Management Areas	Number	0	0	0	0
Estuarine Management Areas	1,000 Ac.	0	0	0	0
Beach Management	Miles	0	0	0	0
Beach Stabilization	Miles	0	0	0	0
River Basin	Number	1	0	0	1
Watersheds	Number	37	7	0	44
Special Studies:					
Preservation of Streams	Miles	478	0	0	478
Scenic Roads	Miles	394	0	0	394
Roadless Areas	1,000 Ac.	35	0	0	35
Minimum Flows	Number				
Other	Number				

1/ Includes municipal, industrial, and recreation uses.

Subregion 10n				Subregion 11				Area Total			
1970-1980	1981-2000	2001-2020	Total	1970-1980	1981-2000	2001-2020	Total	1970-1980	1981-2000	2001-2020	Total
0	0	0	0	60	242	0	302	101	545	0	646
0	1,600	8,000	9,600	1,100	6,900	25,000	33,000	2,230	14,370	39,000	55,600
0	1	2	3	23	135	415	574	46	214	521	780
0											
0	0	0	0	0	0	0	0	0	0	0	0
20	20	0	40	18	24	5	47	38	162	5	205
3	11	0	14	0	0	0	0	3	11	0	14
1,765	1,306	894	3,965	2,026	3,717	6,177	11,920	4,798	7,320	7,965	20,083
1,662	1,469	804	3,935	8,008	1,526	4,442	13,976	12,322	5,309	6,051	23,682
29	47	22	98	394	791	1,148	2,333	546	1,084	1,312	2,942
(3)	(7)	(7)	(17)	(170)	(265)	(495)	(930)	(187)	(295)	(532)	(1,014)
(25)	(39)	(14)	(78)	(222)	(520)	(644)	(1,386)	(356)	(780)	(769)	(1,905)
(1)	(1)	(1)	(3)	(2)	(6)	(9)	(17)	(3)	(9)	(11)	(23)
33	52	26	111	443	889	1,290	2,622	615	1,215	1,476	3,306
2	0	0	2	10	0	0	10	18	0	0	18
20	2	0	22	109	75	14	198	190	207	138	535
0	0	0	0	0	0	0	0	0	0	0	0
39	6	16	61	34	48	37	119	111	64	83	258
0	0	0	0	0	0	0	0	0	0	0	0
74	10	38	122	47	95	77	219	215	127	196	538
150	0	0	150	702	194	15	911	847	194	50	1,091
300	100	60	460	950	300	200	1,450	1,750	550	360	2,660
90	100	90	280	225	565	390	1,180	490	1,250	1,063	2,803
2	1	2	5	24	12	18	54	34	24	23	81
548	265	400	1,213	510	240	370	1,120	1,367	657	996	3,020
9	5	7	21	87	41	63	191	113	54	82	249
17	8	12	37	60	120	190	370	77	128	202	407
2	2	3	7	9	17	37	63	15	21	43	79
130	100	100	330	270	170	600	1,040	575	345	775	1,695
27	15	20	62	80	49	51	180	137	81	92	310
31	44	63	138	98	42	139	279	160	131	253	544
1,062	1,417	1,062	3,541	1,471	1,961	1,471	4,903	3,385	4,515	3,385	11,285
19	6	9	34	43	20	31	94	74	32	49	155
3,000	9,100	15,800	27,900	12,400	44,300	84,300	141,000	16,900	56,200	104,900	178,000
6,200	18,700	33,500	58,400	85,300	244,500	432,000	761,800	102,600	285,800	505,800	894,200
2,800	3,500	7,300	13,600	10,600	12,200	24,000	46,800	14,400	17,200	34,100	65,700
0	1,800	4,300	6,100	5,200	9,200	17,600	32,000	5,400	11,600	23,300	40,300
40	110	200	350	75	350	600	1,025	213	653	1,142	2,008
60	105	103	268	106	192	199	497	205	369	372	946
41	9	13	63	42	46	36	124	120	67	81	268
3,670	3,663	3,650	NA	6,433	6,356	6,209	NA	12,762	12,673	11,982	NA
0	0	0	0	6	54	53	113	6	54	53	113
6	9	8	23	33	65	47	145	61	92	77	230
123	107	85	315	182	198	198	578	486	525	508	1,519
130	172	174	476	37	55	55	147	174	262	259	695
595	588	419	1,602	279	393	393	1,065	1,037	1,240	1,088	3,365
259	1,006	1,714	2,979	10	13	16	39	288	1,034	1,745	3,067
61	194	266	521	598	815	1,055	2,468	660	1,010	1,325	2,995
1	0	1	2	4	5	5	14	11	11	9	31
6	0	0	6	1	0	0	1	7	0	0	7
133	0	0	133	1,600	0	0	1,600	1,733	0	0	1,733
97	0	0	97	130	122	0	252	227	122	0	349
5	24	0	29	3	66	0	69	7	91	0	98
0	0	0	0	0	0	0	0	1	0	0	1
37	25	0	62	84	26	0	110	158	58	0	216
270	0	0	270	1,006	0	0	1,006	1,754	0	0	1,754
260	0	0	260	750	0	0	750	1,404	0	0	1,404
1	0	0	1	578	0	0	578	614	0	0	614
								1	0	0	1
								0	0	0	0

Electric Power

Up to the present time, regional power needs have been met almost exclusively with hydroelectric generation. Although undeveloped hydroelectric sites have been identified which could add 4,696 MW of average energy and increase the peaking capability of the system by 18,295 MW, they would fall far short of meeting requirements by year 2020. Consequently, thermal generation would be required to meet much of the new demand. It was anticipated that thermal capacity would ultimately carry virtually all of the base load while hydro would be used primarily to meet peak loads.

Two alternative electric power systems were considered, a likely maximum hydro system and a likely minimum hydro system, each in combination with sufficient thermal generation to meet projected needs. The maximum hydro system presumed continued major storage development and included all identified potential conventional hydro projects not located on established wild rivers. The minimum hydro system includes only hydro projects which are now existing or under construction. Both plans include all reasonably firm additions to hydroelectric projects existing and under construction, i.e., all authorized additions to Federal projects and all future units for which space is provided at licensed non-Federal projects. The framework plan, which was evolved from consideration of all potential projects in each subregion, nearly approximated the minimum hydro system. For this reason, the maximum thermal cooling water requirements associated with minimum hydro system would be included.

The load resource analysis for electric power, table 22, shows how the framework plan meets the projected requirements for firm energy and peaking capability. For 1980, there would be a slight surplus of peaking capability but balanced energy loads and resources. Considering the practicality of developing hydroelectric peaking capability as needed, it is improbable that a peaking surplus will actually ensue. Cooling water requirements for 2000 and 2020 are based on thermal installations to meet projected energy needs not satisfied by planned hydro installations. Additional capability to meet peak loads or to cover thermal plants temporarily out of service is not identified, and its small water requirement is not derived.

Providing sufficient rights-of-way for the transmission of large amounts of power will present one of the biggest problems in meeting power loads by 2000 and beyond. To reduce environmental impacts of transmission across the Cascades, no new transmission corridors would be opened, but existing lines would be reconductored to much higher capacity. Studies indicate an east to west limitation of about 22,000 MW north of the Columbia River and 33,000 MW south of the Columbia, including an estimated import of 3,000 MW from the Klamath River Basin. In addition, 10,000 MW are assumed to be transmitted from coastal locations to each of the Willamette and Puget Sound Subregions, 3,000 MW to the Upper Snake Subregion, and 6,000 MW to western Montana from outside the region.

Table 22–Electric Power Load Resource Analysis
Columbia-North Pacific Region

Areas	1970 Existing	1970 Under Const.	1970 Nameplate Capacity	1970-1980	1980 Nameplate Capacity	1980 Firm Energy	1980 Dependable Capacity	1980-2000[2]	2000 Nameplate Capacity[2]	2000 Firm Energy	2000 Dependable Capacity	2000-2020	2020 Nameplate Capacity	2020 Firm Energy	2020 Dependable Capacity
								(1,000 mw)							
Area A															
Hydro	8.2	3.1	11.3	3.2	14.5	6.5	14.8	5.3	19.8	6.3	20.7	0.0	19.8	6.3	20.7
Thermal	0.8	0.0	0.8	0.3[1]	1.1	1.0	1.1	2.9	4.0	3.4	4.0	7.0	11.0	9.4	11.0
Area B															
Hydro	2.0	1.4	3.4	1.3	4.7	2.0	4.9	2.3	7.0	2.1	7.7	0.0	7.0	2.1	7.7
Thermal	negl.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Area C															
Hydro	5.3	1.5	6.8	0.0	6.8	3.4	7.5	1.6	8.4	3.4	9.2	0.0	8.4	3.4	9.2
Thermal	0.2	0.0	0.2	1.1	1.3	1.1	1.3	22.9	24.0	20.4	24.0	54.0	78.0	66.3	78.0
Area D															
Hydro	2.1	negl.	2.1	0.1	2.2	0.9	2.2	0.5	2.7	1.0	2.7	0.0	2.7	1.0	2.7
Thermal	0.3	1.4	1.7	2.2	3.9	3.3	3.9	14.4	18.0	15.3	18.0	39.0	57.0	48.4	57.0
Region															
Hydro	17.6	6.0	23.6	4.6	28.2	12.8	29.4	9.7	37.9	12.8	40.3	0.0	37.9	12.8	40.3
Thermal	1.3	1.4	2.7	3.5	6.3	5.4	6.3	40.2	46.0	39.1	46.0	100.0	146.0	124.1	146.0
Thermal Reserve[3]	-	-	-	-	-	-	-	-	9.6	8.2	9.6	-	28.0	23.8	28.0
Imports	-	-	-	-	-	0.5	0.2	-	8.0	6.8	8.0	-	12.0	10.7	12.0
Peaking Resources[4]	0.0	0.0	0.0	0.3	0.3	0.0	0.4	0.0	0.3	0.0	0.4	26.3	26.6	-0.3[5]	30.6
Total	-	-	-	-	34.8	18.7	36.3	-	101.8	66.9	104.3	-	250.5	170.6	256.9
Loads (Including Reserves)	-	-	-	-	-	18.7	33.8	-	-	66.6	102.3	-	-	170.6	256.9

1/ Net reflects discontinuation of operation of Hanford No. 1.
2/ All existing small thermal plants assumed to be retired by 2000, gross increments shown.
3/ Base load thermal installation, not included in subregional breakdown as they will not add to cooling water requirements.
4/ Pumped storage, gas turbine, and/or other types of peaking plants.
5/ Net energy loss required to support pumped-storage peaking plants.

AD-A036 545 PACIFIC NORTHWEST RIVER BASINS COMMISSION VANCOUVER WASH F/G 8/6
COLUMBIA-NORTH PACIFIC REGION COMPREHENSIVE FRAMEWORK STUDY OF --ETC(U)
SEP 72 E J GULLIDGE, G J GRONEWALD

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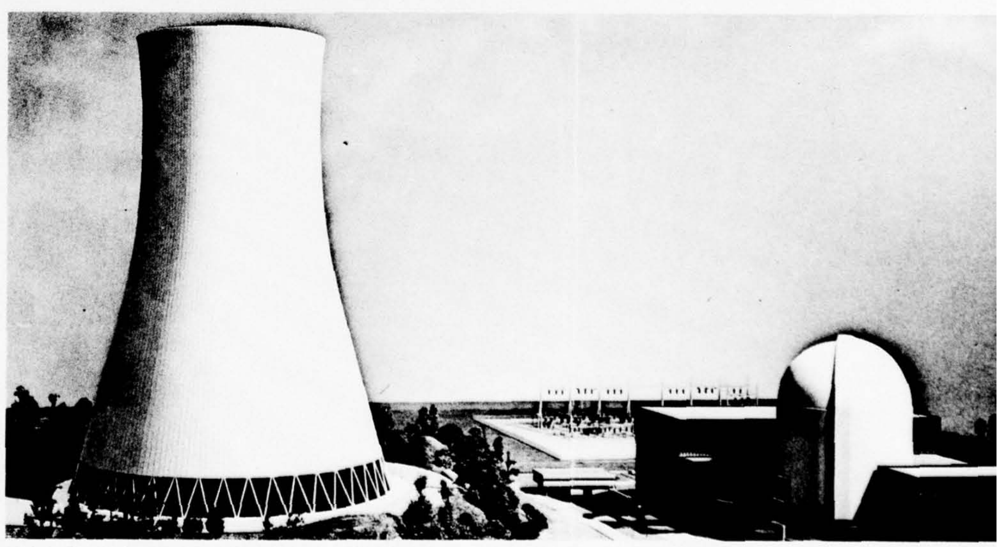
Direct cooling for thermal plants was not acceptable, except i limited salt water cooling and for special circumstances where the cc water would not be directly returned to the waterway. On the basis c technology, most thermal developments in the near future would be lig nuclear reactors. Sometime between 1980 and 2000, liquid metal breec reactors would become feasible, and subsequent plants would be of tha By 2020, many of the earlier light water reactors will have been repl the more advanced LMB reactors. On this basis the annual consumptive water would be 746,000 acre-feet by 2000, and about 2.1 million acre 2020.

Siting guidelines followed by a general survey are needed to d areas suitable for thermal plants. To minimize transmission distance logical pattern of thermal installation would call for the most capab near major load centers in the Willamette Basin and Puget Sound areas

Large thermal plants are expected to satisfy a major portion o future power load, but their inability to supply economical peaking p would result in the development of pumped-storage or other types of p plants. Studies indicate that the peaking requirements of the region be met until about 2000, by adding base-load thermal plants and addit generating units at existing conventional hydroelectric projects. Wh of those units is completed, other sources of peaking power must be d Although many pumped storage sites exist, there is no regionwide plan installation of peaking units. The location of those plants is somew flexible. Accordingly, peaking resources have not been divided betwe pumped storage and other sources.



Architect's model of the Trojan Nuclear Plant under construction on the lower Columbia River. The natural draft rise 499 feet in height and have a base diameter of 385 feet (Portland General Electric).

Table 22—Electric Power Load Resource Analysis
Columbia-North Pacific Region

Areas		1970			1980				2000				2020		
	Existing	Under Const.	Nameplate Capacity	1970-1980	Nameplate Capacity	Firm Energy	Dependable Capacity	1980-2000[2]	Nameplate Capacity[2]	Firm Energy	Dependable Capacity	2000-2020	Nameplate Capacity	Firm Energy	Dependable Capacity
								(1,000 mw)							
Area A															
Hydro	8.2	3.1	11.3	3.2	14.5	6.5	14.8	5.3	19.8	6.3	20.7	0.0	19.8	6.3	20.7
Thermal	0.8	0.0	0.8	0.3[1]	1.1	1.0	1.1	2.9	4.0	3.4	4.0	7.0	11.0	9.4	11.0
Area B															
Hydro	2.0	1.4	3.4	1.3	4.7	2.0	4.9	2.3	7.0	2.1	7.7	0.0	7.0	2.1	7.7
Thermal	negl.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Area C															
Hydro	5.3	1.5	6.8	0.0	6.8	3.4	7.5	1.6	8.4	3.4	9.2	0.0	8.4	3.4	9.2
Thermal	0.2	0.0	0.2	1.1	1.3	1.1	1.3	22.9	24.0	20.4	24.0	54.0	78.0	66.3	78.0
Area D															
Hydro	2.1	negl.	2.1	0.1	2.2	0.9	2.2	0.5	2.7	1.0	2.7	0.0	2.7	1.0	2.7
Thermal	0.3	1.4	1.7	2.2	3.9	3.3	3.9	14.4	18.0	15.3	18.0	39.0	57.0	48.4	57.0
Region															
Hydro	17.6	6.0	23.6	4.6	28.2	12.8	29.4	9.7	37.9	12.8	40.3	0.0	37.9	12.8	40.3
Thermal	1.3	1.4	2.7	3.5	6.3	5.4	6.3	40.2	46.0	39.1	46.0	100.0	146.0	124.1	146.0
Thermal Reserve[3]	-	-	-	-	-	-	-	-	9.6	8.2	9.6	-	28.0	23.8	28.0
Imports	-	-	-	-	-	0.5	0.2	-	8.0	6.8	8.0	-	12.0	10.7	12.0
Peaking Resources[4]	0.0	0.0	0.0	0.3	0.3	0.0	0.4	0.0	0.3	0.0	0.4	26.3	26.6	-0.3[5]	30.6
Total	-	-	-	-	34.8	18.7	36.3	-	101.8	66.9	104.3	-	250.5	170.6	256.9
Loads (Including Reserves)	-	-	-	-	-	18.7	33.8	-	-	66.6	102.3	-	-	170.6	256.9

1/ Net reflects discontinuation of operation of Hanford No. 1.
2/ All existing small thermal plants assumed to be retired by 2000, gross increments shown.
3/ Base load thermal installation, not included in subregional breakdown as they will not add to cooling water requirements.
4/ Pumped storage, gas turbine, and/or other types of peaking plants.
5/ Net energy loss required to support pumped-storage peaking plants.

The bulk of the new hydro capacity, which consists of additions to existing plants, was selected on the basis of the most economical and practicable units; consequently, the economic efficiency objective is satisfied. By adding most of the new hydro capacity at existing plants and making maximum use of existing transmission corridors, environmental impacts would be minimized. Thermal plant locations would require additional study to minimize their impacts. A plan to meet the regional development objective would require additional generating capacity in each time period and probably would have more plants in the area west of the Cascades to minimize transmission costs as well as satisfying additional peaking capability.

Conversely, an environmental objective that envisioned a lesser degree of development would require less power and fewer powerplants. Every effort has been made to minimize environmental impacts while meeting the needs. To this extent the plan is compatible with the environmental objectives. However, each cooling tower would emit a plume of cool steam into the atmosphere, and any heat injected into the salt water could have significant, though not necessarily detrimental, effects on local ecosystems.

Navigation

Foreign and domestic coastwise waterborne commerce is forecast to increase from about 45 million tons in 1968 to almost 200 million tons in 2020. Internal commerce is projected to increase from about 52 million tons in 1968, to over 190 million tons in 2020. On the Columbia-Snake system, waterborne commerce is forecast to increase from 11.5 million tons in 1968, to 20.1 million tons in 2020. On the Willamette waterway, the increase is expected to be from 5.3 million tons in 1968, to 13.2 million tons in 2020.

Programs and facilities which have been identified to assure these movements are shown by area and time period on table 17 and figure 25. To the extent that there is increased marine traffic, either commercial or recreational on the navigable waters, there will be requirements for more aids to navigation, search and rescue services, law enforcement, and other related activities by the U. S. Coast Guard. These services will be provided on a level consistent with national priorities. There will be requirements for like services from local jurisdiction at least in non-Federal waters.

The framework plan for the 1970-1980 period includes completion of the lock and 32 miles of channel at Lower Granite Dam, and enlargement of Bonneville lock to at least equal the size, 86 feet by 675 feet, of the upstream locks. In the Oregon coastal area, 36 miles of channel would be improved and 2 miles of breakwaters constructed to aid navigation conditions at Coos Bay, Siuslaw River, and entrance of Rogue River. In Washington, 38 miles of channels would be deepened or extended in Grays Harbor and the Puget Sound area and 3 miles of breakwater at Grays Harbor would be rehabilitated.

Piers 39 and 40, typical of the Seattle waterfront (USCE).

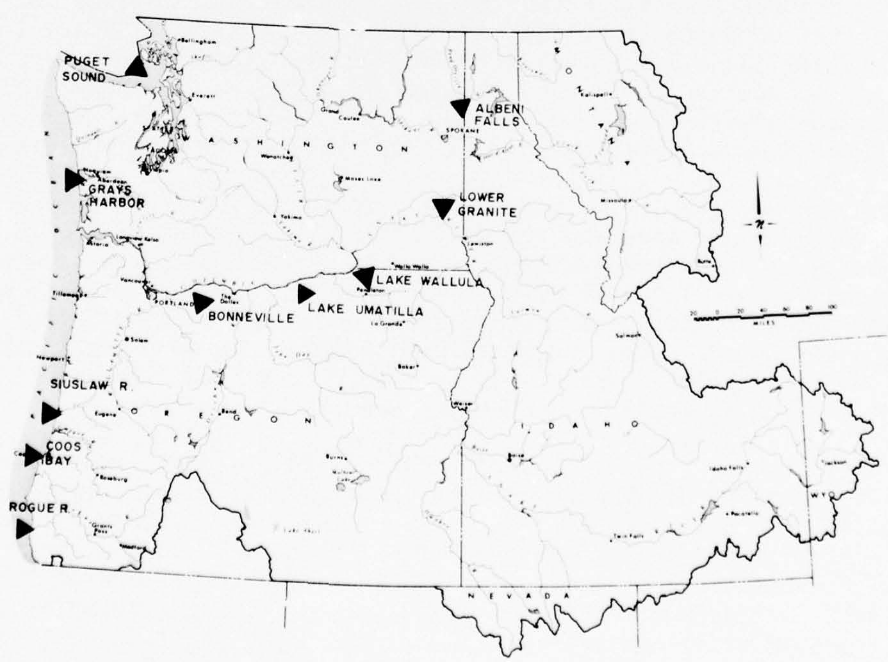


FIGURE 25. Locations Subject to Navigation Improvements

Other navigation features include a pleasure boat transfer facility at Albeni Falls Dam on the Pend Oreille River, improvements to the approach channels to locks at Bonneville, John Day, and McNary Dams, and the removal of shoals from the upper reaches of Lake Umatilla and Lake Wallula. The railroad bridge at Lake Wallula would be modified to remove hazards to navigation. A study would be made to assess the need for increased channel depths along the lower Columbia River below Bonneville Dam and to develop a plan for disposal of dredged spoil.

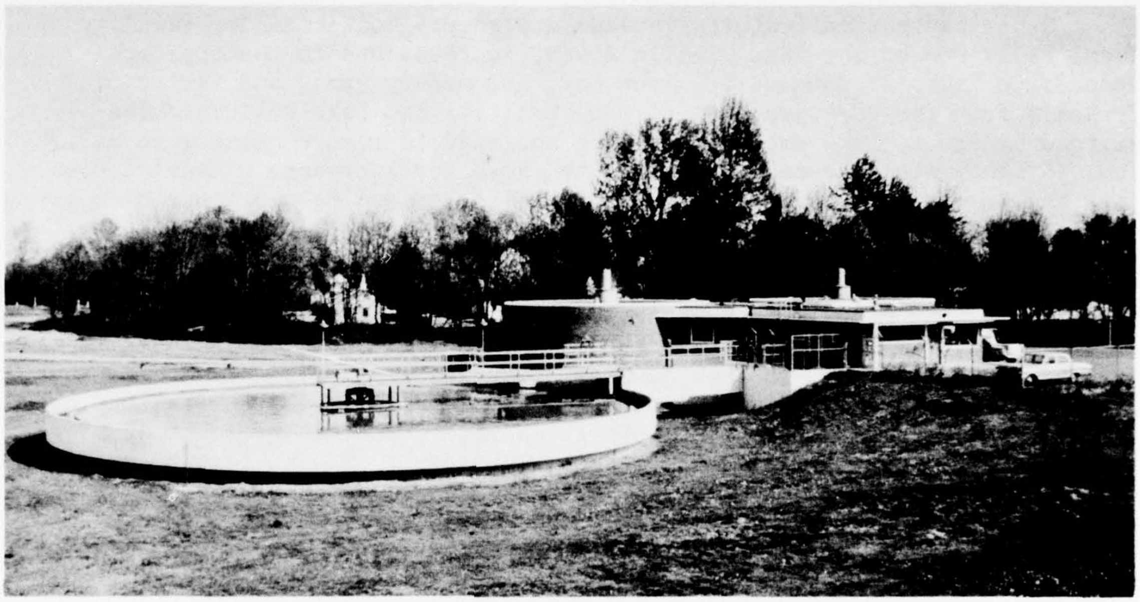
In the 1980-2020 period, a project comprising 57 miles of intermittent channel deepening below Priest Rapids Dam and the installation of locks in existing Priest Rapids, Wanapum, and Rock Island Dams would be included if found acceptable through further studies. Studies would also be made to determine if navigation should be extended up the Snake River to its confluence with the Grande Ronde River. The authorized reconstruction of locks at Willamette Falls and 106 miles of channel improvements for navigation are also a part of the plan. About 162 miles of channel would also be deepened or extended along the lower Columbia River, at Willapa Bay, and in the Puget Sound area; 11 miles of breakwater would be constructed. Other elements would consist of improvements to the channel of the lower St. Joe River in Idaho and a study to determine minimum flows for navigation on the Snake River above its confluence with the Salmon River.

Navigation elements would meet the economic efficiency objective. The regional development objective also would be satisfied with only minor modification of the time schedule.

Navigation has some conflicts with environmental quality objectives, and some of the considered improvements could cause further problems. Disposal of dredge spoil from maintenance of the deep draft navigation channel in the lower Columbia and Willamette Rivers and in the estuaries is already a problem in some areas which further deepening of the channel would compound. The problem can be minimized through careful selection of disposal areas. Except for spoil disposal, the deeper channels needed for future navigation would not significantly increase environmental problems, although the changed flow patterns caused by altered hydraulic charactistics may affect water quality and aquatic life. Also, control and greater care are needed to avoid accidental spills of petroleum, dumping of garbage, and washing of bilges.

Water Quality Control

The framework plan includes reduction of recreational, municipal, and industrial wastes through increased levels of treatment. Although raw waste production is expected to reach 95 million population equivalents in 2020, treatment would reduce the discharge to a waste equivalent of about 16 million people.



Sewage treatment plants such as this will become a more common sight in the future.

The treatment called for is 85 percent removal of oxygen demanding wastes by 1980 and 90 percent thereafter. The only exception would be for treatment of wastes discharged in certain marine waters of the Puget Sound Subregion, where primary treatment with 35 percent to 45 percent removal was deemed adequate to meet state standards. This was recognized as a potential deficiency, and Federal and State authorities are reviewing present waste treatment requirements for the Puget Sound area. An accelerated program of treatment is required in most of the region to meet the water quality goals.

As waste treatment does not provide an economic solution for complete removal of contaminants or cannot be applied to noncollectable wastes, a certain amount of streamflow is necessary for dilution and assimilation of residual wastes reaching the streams. The minimum flow requirement is related to a number of factors, including deoxygenation capacity of the wastes, and the temperature, reaeration capacity, elevation, and minimum allowable dissolved oxygen for the stream. Minimum instream flows are required for fisheries and esthetic values. Such flow requirements would probably be sufficient to assimilate any wastes that may reach the streams. Studies to establish minimum flow requirements are needed throughout the region.

One of the more important features of the water quality plan is provision for continuous monitoring to insure that all control or treatment measures are functioning. A basic network would be required for both fresh

water areas and the marine waters of Puget Sound and other estuaries. Provisions for adjustments to conform to waste source changes would be established.

Strict control would be maintained on mining, dredging, construction, and other activities which cause pollution or otherwise degrade the quality of water. Particular attention would be paid to prevention of petroleum spills and dumping of ship bilges in restricted waters.

Recreation developments would include adequate provisions for collection and treatment of wastes. Boats would be required to retain wastes on board until they can be discharged on shore or on the open ocean.

Nitrogen supersaturation in the Columbia and Snake Rivers presents a serious problem to the fishery resource. Steps to alleviate this problem are being taken by Federal and State interests.

Land treatment measures and improved irrigation techniques would not only improve agricultural production but would also reduce contamination of waterways through decreased erosion and surface runoff. Although not strictly a waste discharge, erosion is a major contributor to reduced water quality, particularly in the steep wheat-fallow areas of southern Idaho and in the Palouse drainage. Improved land use and management practices are included in the plan to minimize this source of pollution.

The animal population, a source of organic wastes, is projected to reach 87.5 million population equivalents by 2020. To prevent the wastes from possibly entering the water sources, construction of fences and simple retaining structures between the animal habitat and watercourses is recommended to limit direct surface drainage so that wastes may decompose through soil processes. At some places, it may be preferable to collect the waste from cattle-holding facilities for treatment or spreading on the land as fertilizer.

The plan calls for treatment of mining industry wastes from the Metaline Falls and Coeur d'Alene areas. In the Butte-Anaconda area, where the primary metals operation uses Silver Bow Creek to carry wastes to treatment facilities in the vicinity of Warm Springs, the problem could be eliminated by the reclassification of Silver Bow Creek by the State of Montana to prohibit untreated wastes from being discharged into the stream. Inadequate control of seepage from mine ponds and tailings has an adverse effect on water quality. Every effort should be made to locate these sources and seal them off or provide other measures to prevent the toxic seepages from reaching the waterways.

Additional studies are required in the Flathead Lake area to determine means of alleviating a growing pollution and nutrient problem in the lake and some of its tributaries. Sampling and other studies are necessary to determine the source and method of collection and treatment.

The disposal of rural wastes by septic tanks and drain fields will con-

tinue to represent a possible hazard to the ground-water aquifer of the Spokane area, as well as a few other more localized areas. In the lake areas, particularly the Spokane area, and Coeur d'Alene, Priest, Pend Oreille, and Flathead Lakes, it is recommended that collection and treatment of wastes from summer homes and houseboats be provided. Sewage disposal systems adequate to cope with weekend loads would be needed in these and other recreation areas. Other recommended measures include facilities for collection and pickup of litter and garbage, and restrictions on motor boats on heavily used lakes to keep oil and gas pollution at a minimum.

The waste discharge of the Spokane service area with 85 percent treatment would require a flow in the Spokane River of 2,950 cfs in 2020, a situation which would not be met approximately 44 percent of the time; and, even at 95 percent level of treatment, the minimum flow of 1,500 cfs would be deficient about 5 percent of the time. Because of the potential deficient streamflows and existing algal blooms in Long Lake, higher degrees of treatment to remove the maximum amount of organics and nutrients from the waste streams before discharge into the Spokane River are proposed in addition to augmentation of low water flows.

The mineral content of Crab Creek below Potholes Reservoir, where dissolved solids range from 300-350 mg/1, is significantly increased by ground-water inflow and agricultural return flows. At the confluence of Crab Creek with the Columbia River, the mean total dissolved solids concentration is about 750 mg/1. Dissolved oxygen remains at a relatively high level through this reach of the creek. Coliform densities as high as 46,000/100 ml have been reported in the lower Crab Creek. Excessive algal growth has interfered with recreational and fisheries uses of Moses Lake. These conditions appear to result from nutrient inflow from ground water, domestic wastes, and agricultural return flows. Abatement measures would include land treatment controls and management practices. The plan includes storage in the 1980-2000 period to augment flows in lower Crab Creek, and thus improve the water quality.

Low summer flows with high temperatures in the lower reaches of the Yakima River are detrimental to fish passage; high nutrient concentrations stimulate excessive growths of aquatic blooms; and high coliform densities prevent safe, water-contact recreation activities in the Yakima River from Ellensburg to the mouth. Waste treatment included in the framework plan would aid in solving the organic and bacterial problems. Reallocation of existing storage and new storage are needed to provide for improved water quality as well as other uses. Some additional storage would be provided by 1980, and the remaining by 2000 and 2020.

Ground-water contamination, a threat in those areas overlying the Snake Plain Aquifer, is now under study to determine the needed controls. It may be necessary to replace septic tanks in some areas with sewage collection systems or prohibit discharging these wastes to wells. Seepage from septic tanks, a source of bacterial contamination along the Payette River, Payette

Waste being discharged into the Snake River, 1966 (Idaho Fish and Game Dept.).

Lake, and the Boise River, should be collected and treated.

In the critical reach of the Snake River from Heise to below Milner Dam, several alternatives for flow augmentation have been laid out. However, further study of the ground-surface-water relationship and the other potential uses of water is required before an acceptable solution can be devised. For purposes of this study, it is assumed that the alternative of a combination of storage and ground-water pumping would be used to satisfy needs.

The plan for Subregion 11 provides that the effluent from the Renton secondary sewage treatment plant would be diverted from the Green-Duwamish River directly into Puget Sound if necessary to maintain the quality of the river. A study would be made of the entire Lake Washington system to determine a means of handling increasing loads of nutrients as urban buildup continues. The salinity intrusion into the lake from lockages between Lake Washington and Puget Sound and increased diversions from the Cedar River would also be studied.

Future treatment of wastes discharged into marine waters in the Puget Sound Area will be determined by a Federal-State study which is now underway. Along with these treatment levels, the plan provides for extending sewer lines to serve a greater portion of the population and for separation of storm and sanitary sewers. Tertiary treatment would be provided for sewage flowing into certain lakes.

The broader water quality aspects of the plan include: (1) improved waste treatment facilities, (2) minimum flows as needed for water quality purposes in streams where water quality problems cannot be solved entirely by waste treatment, (3) legislation to prohibit discharge of wastes from boats and ships, (4) modification of dredging practices to minimize turbidities and to reduce the toxic and oxygen demanding materials, (5) correction of nitrogen supersaturation along Columbia and Snake Rivers, (6) land treatment and improved irrigation techniques to reduce erosion and contamination of streams, (7) control of organic livestock wastes to prevent them from entering water courses, (8) measures to relieve special problems as previously described in this section.

The accomplishment of these water quality control measures would provide environmental quality and aid the well-being of people. A healthful environment, of which water is a major component, would increase the ability of regional industries to attract and hold a stable work force. High quality waters are also essential to many industries, including food processing and pulp and paper, which are major components of the regional industrial mix. Accordingly, maintenance and improvement of water quality are in consonance with national economic development, environmental quality, and the well-being of people.

Municipal and Industrial Water Supply

Provision of municipal and industrial water supplies are programmed on a fairly uniform basis to match demands and no critical problems are foreseen. Total water supply requirements by 2020 are about 8,624 MGD or 2.8 times the present use. This requires an annual withdrawal of 9.7 million acre-feet by 2020. Planned water supply programs fully satisfy these needs.

Sufficient water is generally available to meet projected municipal, industrial, and rural-domestic needs, although some local problems have or may develop. In addition, the necessary level of treatment would increase as more use of surface water occurs or as ground-water quality declines.

The objective of the region's municipalities, industries, and individual water purveyors is to develop satisfactory water supply systems geared to meet needs. The planning objectives, regional development and economic efficiency, require adequate municipal and industrial water supplies. Water is generally available to meet future needs, and satisfying these needs is not expected to conflict with environmental quality objectives in most areas. However, depletions of surface and ground-water sources in some areas would have adverse impacts on quality. Careful consideration of all factors in selecting and developing future supplies would be required to minimize or avoid these impacts.

The framework plan identifies measures for conveyance to the point of distribution and treatment as required to bring the quality to interstate standards.

Municipal Water Supplies

Solutions to major municipal water supply problems, identified in the framework plan, are shown in figure 26.

Potential municipal water supply problems facing the suburbs of Spokane and Missoula are the contamination of individual and municipal ground-water supplies by subsurface disposal of domestic wastes. The obvious solution to protecting the aquifers is to provide the areas with sanitary sewers and water distribution systems.

Ground waters in the vicinity of Moses Lake contain concentrations of nitrogen greater than the limits (10 mg/l as nitrogen) recommended by the Public Health Service Drinking Water Standards. Higher levels of treatment would be required as water needs increase and as the quality of the ground water deteriorates. The quality of the ground water could be controlled to some degree by improving agricultural practices.

Except for the headwaters, the quality of surface waters in the Yakima River Basin is generally undesirable for municipal water supplies without complete treatment. Optimum spacing of wells and pumping scheduled to fit available supply would be required to effectively use ground waters. On occasions it would be necessary to resort to surface waters to meet the

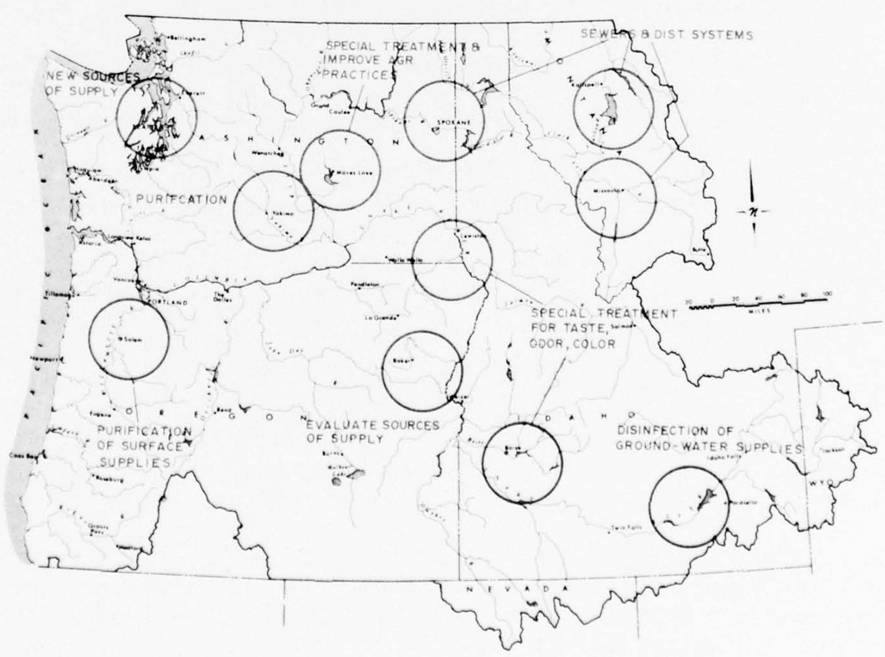


FIGURE 26. Some Planned Solutions to Municipal Water Supply Problems

increased requirements. The city of Yakima has recently installed a treatment plant on the Naches River to replace its existing ground-water supply system.

The Snake River Basin, in Subregions 4 and 5, overlies high yield aquifers that should easily supply future needs. Quality problems, resulting from seepage into the ground water, may become a problem and require specialized treatment; this potential problem is under investigation. The aquifer underlying the Boise area has excessive mineral and bacterial concentrations; disinfection is already practiced but specialized treatment for taste, odor, and color may be necessary in the future.

Both quantity and quality may be problems for some communities in Subregion 5, particularly in Oregon. Each would require an individual study to identify and evaluate alternative sources of supply.

Most existing water supplies in Subregion 6 are considered adequate to meet future demands, but all would require disinfection and most surface supplies would need complete treatment. The towns of Salmon and Challis are supplied from small creeks which may not be adequate; but the Salmon River is nearby. In the Pullman, Washington, service area where ground-water levels have been steadily dropping, studies have identified several surface-water sources.

Both quantity and quality problems are present in the Grande Ronde Basin. Additional development would involve the use of surface water and require special treatment for taste, odor, and color.

In Subregion 7, local shortages occur at the towns of Walla Walla, Dayton, The Dalles, and several other communities. No serious water supply problems are anticipated as supplies could be obtained from local ground and surface sources.

Most of the population of Subregion 9 is expected to be served by central systems by 2020. Water supply problems may be solved by storage, transmission, or treatment; however, small communities are seldom able to finance the improvements. Water treatment practices vary at the present time, but all surface water would require complete purification in the future.

Municipal water systems serve two-thirds of the population in Subregion 10S with approximately 75 percent of the water supplies from surface sources. The quality and quantity of the water are generally adequate; however, some municipalities have inadequate sources such as small coastal streams, springs, and wells. Several systems do not hold adequate water rights.

Summer water shortages occur at Rainier, Oregon. Future water needs in the Chehalis-Centralia service area are expected to exceed present supplies, but other sources are available, the most readily obtainable being the Chehalis River. Some of the basins in the Puget Sound Area, Subregion 11, would have

shortages requiring study of interbasin transfers, greater utilization of ground water, and possibly even desalinization.

Ground water without treatment is utilized by all water systems in the Closed Basin of Oregon, Subregion 12.

By 2020, three-fourths of the population would be utilizing municipal water distribution systems. Under the framework plan, water supply demands would be met for the most part by expansion of existing systems.

Industrial Water Supplies

Sufficient quantities of ground and surface-water are available to meet the projected industrial water requirements, and no problems are anticipated. However, there may be isolated situations requiring storage to meet peak demands. Treatment may be necessary in some instances to meet industrial requirements.

Rural-Domestic Water Supplies

Rural-domestic supplies are obtained from wells, springs, or headwater streams and are generally adequate although some localized shortages occur during the summer months. Some quality problems have occurred and others are expected. Sea water has encroached into aquifers on Whidbey Island and other shoreline areas, and this can be expected to increase with greater use of ground water. Bacterial contamination can also be expected as suburban expansion continues. These problems would probably lend themselves to use of surface water with necessary treatment plants and distribution systems. Existing sources appear ample to meet projected growth, but contamination must be continuously monitored, and disinfection of each supply may be necessary. However, sound waste disposal practices and major reliance on ground water would minimize this problem.

Flood Control

In 1970, average annual flood damages of $34 million occurred on 1.6 million acres of flood plains along major streams and tributaries. These damages are projected to increase to about $46 million in 1980, $76 million in 2000, and $135 million in 2020. These projections assume that future land use would closely follow existing patterns and that flood damages would be in proportion to the development in the flood plains. In addition, 2.3 million acres are flooded by minor tributaries causing damages estimated at nearly $36 million annually. These damages are projected to increase to $84 million by 2020.

Flooding at Vanport on the Columbia River, June 1, 1948 (USCE).

Flood damage along the North Umpqua River, January 1965 (USCE).

The objective of flood control is to attain proper use of all flood plain areas consistent with the needs of the region, the potential of each flood plain area, and the practicability of providing protection. Therefore, the flood control program is a mix of nonstructural and structural measures. Zoning and regulation are proposed for nearly all flood plains to assist in reducing future flood damages by encouraging appropriate use of flood plain areas and by restricting other uses.

Nonstructural Measures

An effective program of land use regulations is urgently needed throughout the region to prevent development in areas that cannot be feasibly protected and to control development in areas having only partial protection. The flood plain information program authorized by Congress provides a vehicle for disseminating information to local interests as to flood hazards, the extent to which developments should be limited, and the types of regulations required.

Study programs by the Corps of Engineers, Soil Conservation Service, or Geological Survey provide data for planning appropriate regulations. The laws of the states of Oregon, Washington, Idaho, and Montana allow local governments to enact flood plain regulations. Similar laws are needed in Wyoming. The plan proposes flood plain information studies on all major streams which have not yet been considered under these programs.

Effective flood plain regulation programs, adopted now and vigorously enforced, would prevent more than 15 percent of the damages projected to occur along major streams through 2020. Only 25 counties in the region now have effective flood plain regulation in effect. Figure 27 shows where flood plain information reports have been completed.

Flood plain regulations have little effect on damages to structures presently occupying the flood plain. Accordingly, flood proofing would be accomplished to protect existing development where flood control works are not warranted or desired at this time. In addition, the plan encourages all flood prone communities to qualify for flood insurance through the National Flood Insurance Program.

The Columbia-North Pacific Region has an effective flood forecasting organization, the Cooperative Columbia River Forecasting Unit. Streamflow forecasts including flood warnings are routinely made for 122 locations, and additional forecast points are added as requirements are made known. The long-range forecasts provide the basis for advance preparation which is very effective in averting potential losses when coping with spring snowmelt floods.

Another activity useful in decreasing losses and human suffering accompanying floods is the "flood fight" which includes actions taken prior to and during a flood emergency to reduce losses, and following the flood to restore essential facilities and prevent compounded damages by subsequent high water.

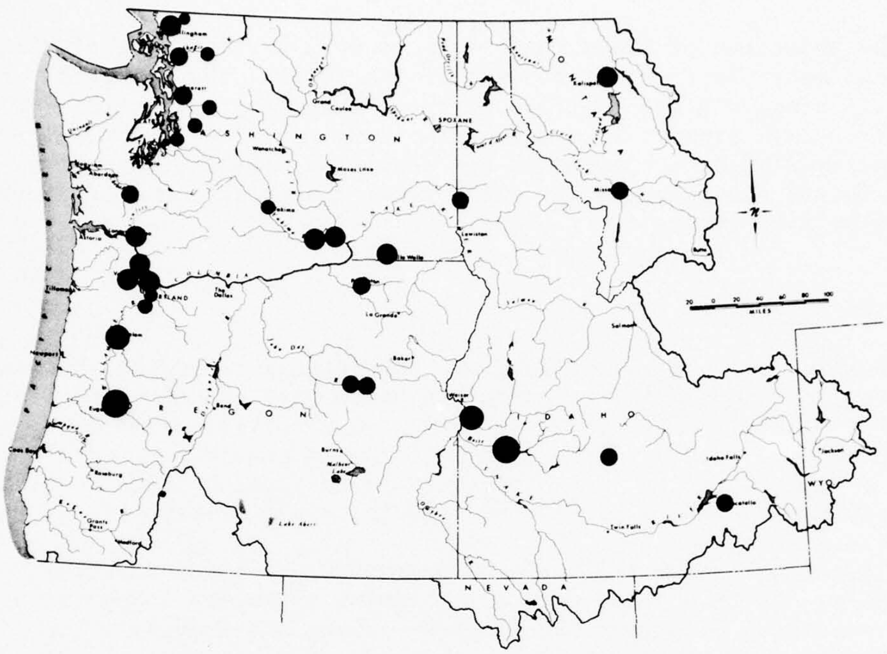


FIGURE 27. Localities with Completed Flood Plain Information Reports

The framework plan calls for flood insurance, flood proofing where applicable, and for continuation and improvement of flood forecasting, advance preparation, and flood fighting.

Structural Measures

Structural measures would consist of 1,303 miles of levees and minor channel improvement, 12,000 acre-feet of single-purpose flood control storage, and use of several million acre-feet of multiple-purpose storage as discussed under "Multipurpose Reservoir Storage." The 1970-1980 period includes 433 miles of channels and levees and 11,000 acre-feet of exclusive flood control storage. The middle period includes 612 miles of channels and levees, and the last period 258 miles plus 1,000 acre-feet of exclusive storage.

A general criteria was adopted to provide structural protection up to floods of standard project magnitude whenever reasonable. Where that level of protection is not provided, urban and suburban areas would be protected from floods of a magnitude likely to occur once in a hundred years. Rural areas in which homes are located would be protected from floods likely to occur once in 25 years.

Structural measures, by area, subregion, and time period, are shown on figures 28 and 29.

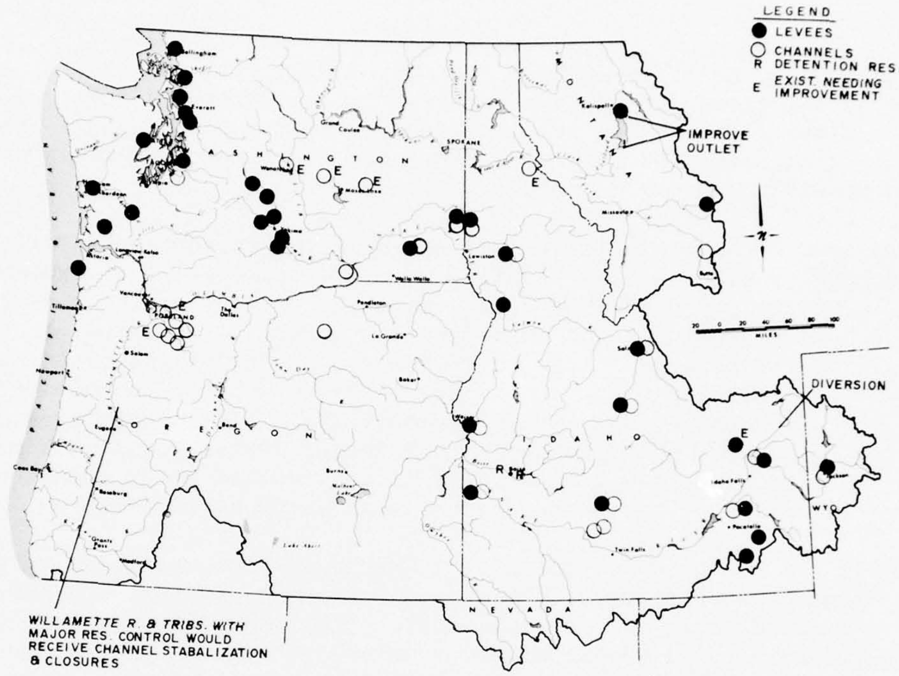


FIGURE 28. Local Flood Protective Works, 1970-1980 Program

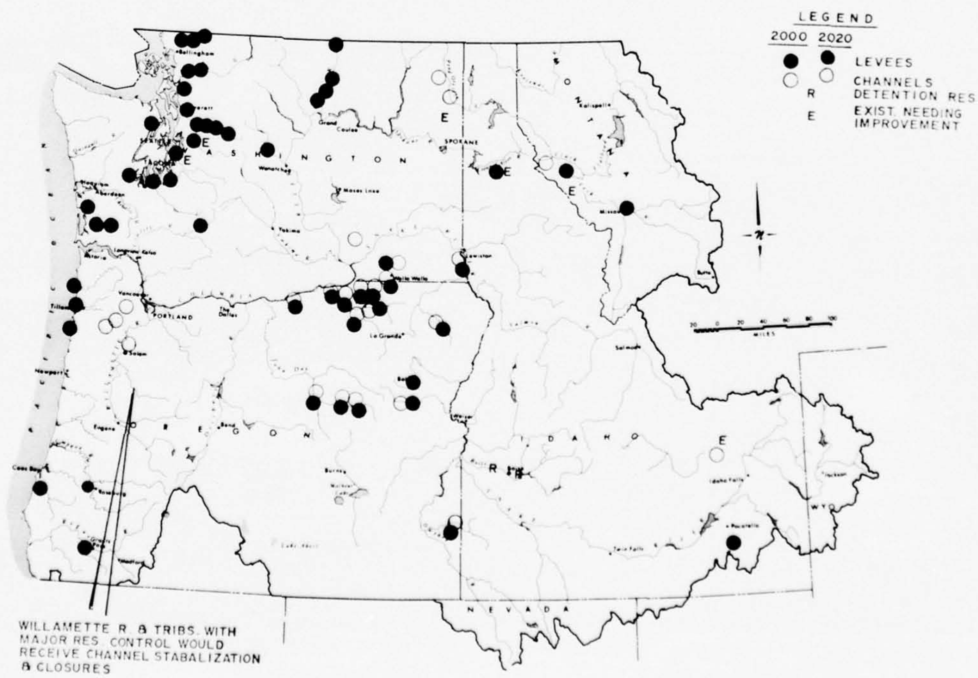
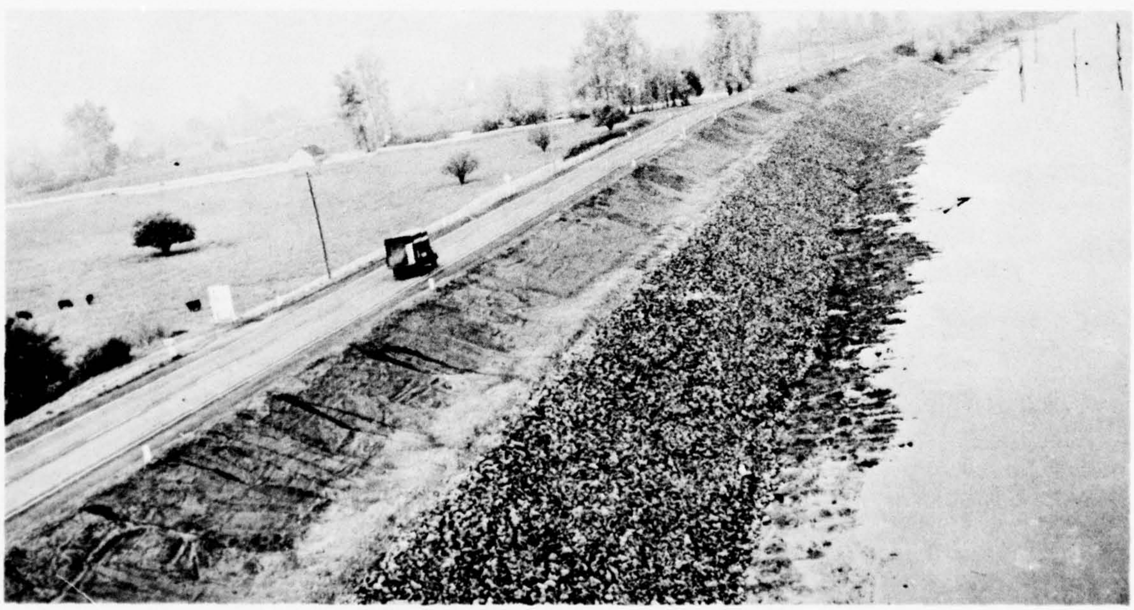


FIGURE 29. Local Flood Protective Works, Long Range Program

In Area A, multiple-purpose storage of 2.24 million acre-feet would be operated for flood control and conservation purposes. A total of 186 miles of levees and channels are included in the framework plan. These local protection works would be both single-purpose and supplement the protection afforded by storage where it exists.

In Area B the study identified the need for further consideration of small reservoirs with a total capacity of 6,300 acre-feet. All would be located in normally dry canyons along the northern edge of the city of Boise, and flood control would be the only function served. The joint use of storage in all multiple-purpose reservoirs for flood control was also included. Ground-water recharging of the Snake River Aquifer should be made for flood control and conservation uses at three locations. Total protection works comprising new levees or improvement to existing levees along with associated channel clearing or rectification would be constructed at 29 locations. In aggregate 137 miles of levee and channel work would be constructed.

With the exception of the Zintel Canyon Project, no major single-purpose flood control storage is planned in Area C; however, the multiple-purpose storage described under reservoir storage would be operated for flood control. A total of 445 miles of levees and channel works are included in the plan. These local protection works supplement the protection afforded by storage where it exists.



Riprap along the lower Columbia River (USCE).

Structural measures included in the framework plan for Area D flood protection include some 949,300 acre-feet of flood control and joint use storage and 535 miles of levees, bank protection, and channel improvement work on major streams.

In addition to the above improvements, flooding would also be alleviated on many tributary watersheds by land treatment measures and small ponds or reservoirs. These measures and practices are described under "Related Land Programs."

Flood control needs for this study have been expressed as average annual damages in 1967 dollar values. Accomplishment measured as damages prevented are given in table 23.

Significant reductions in bank erosion damages and in flood damages along minor streams would also be provided by measures included in this and the land measures programs, but these reductions were not evaluated in terms of dollars.

The economic efficiency, regional development, and environmental quality objectives would be satisfied by a combination of nonstructural and structural programs.

Future flood damages would be curtailed through proper and timely utilization of flood plain regulations. Development that is not allowed in the flood plain could usually be located in a nearby flood-free location, and thus not be lost to the particular general area.

Control of flooding, in itself, enhances man's environment. With careful planning of flood control structures, most conflicts with the environmental objective could be minimized. However, when reservoir storage is used, there is some loss of land and free-flowing streams. These factors were analyzed and evaluated when considering storage projects. As a result, several potential large storage projects were omitted.

Table 23—Planned Reduction of Flood Damages, Major Streams
Columbia-North Pacific Region

	1980		2000		2020	
Area	$1,000	Percent	$1,000	Percent	$1,000	Percent
A	3,205	59	7,012	67	15,250	73
B	1,356	35	2,616	44	4,465	45
C	6,863	46	17,350	67	33,444	70
D	9,438	67	19,420	80	39,802	88
Region	20,862	54	46,398	70	92,961	75

The regional development objective is reflected, to some extent, in Subregions 9 and 11 through use of the higher projections contained in the comprehensive water and related land resource studies of the Willamette River Basin and Puget Sound and adjacent waters.

Irrigation

Although some 7.5 million acres are now being irrigated, the region still has some 33 million acres of potentially irrigable land. Approximately 43 percent of this irrigable land is class 1 or 2, capable of producing high yields of all climatically adapted crops.

Based on the region's allocated share of projected national food and fiber needs, and taking into account expected yield improvement from both dry and irrigated lands, the required additional new irrigation was estimated to total 2.6 million acres by 1980, 3.9 million acres by 2000, and 6 million acres by 2020. In addition, the nearly 2 million acres of currently irrigated, water-short lands would require a full water supply.

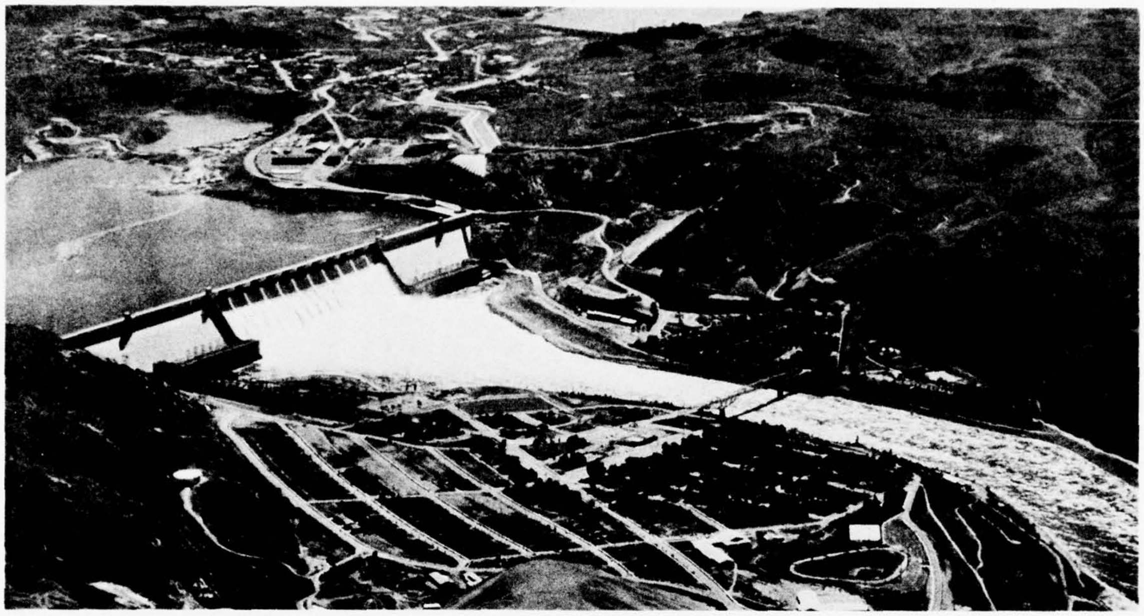
The framework plan includes the development of over 6 million acres of new irrigation, but would only provide supplemental water to about 1.5 million acres, or 74 percent, of the water-short land. Table 24 shows the distribution of planned irrigation and estimates of water diversion and water depletion by river, subregion, and area by time periods.

Nearly all irrigation development in the Clark Fork and Kootenai Basins would be confined to the narrow river valleys where direct diversion facilities would provide the water supplies. In the Bitterroot River Basin, irrigation is presently quite extensive, but about 43,000 acres of the 119,000 irrigated acres do not receive an adequate water supply. Adequate water supplies for the projected 21,000 acres of new lands and the lands needing supplemental supplies, would require new storage along with exchange of water rights between irrigation districts, rehabilitation of existing canals and ditches, and the conversion of ditches to pressure pipe systems.

In the Flathead River Basin, the planned irrigated acreages are expected to be served primarily by pumping from the Flathead River and tributaries, Flathead Lake, and ground water, with small reservoirs providing some supplemental supplies.

Acreages planned for irrigation along the Lower Clark Fork, Kootenai, and Pend Oreille Rivers would receive their water supplies by direct diversion from streams and ground water. About 40,000 acres would be irrigated from the latter source.

About 190,000 acres are expected to be irrigated in the Spokane River Basin. In the Clayton-Deer Park area, about 91,000 acres could be developed by diversion from the Spokane River which would require upstream or offstream storage of 150,000 acre-feet.



Grand Coulee Dam—giant contributor to development in central Washington (USBR).

In central Washington, 1,116,000 new acres are planned for development by 2020. Some 95 percent of these lands would be in the Big Bend area where 560,000 acres of the Columbia Basin Project remain to be developed. The water supplies for the remaining 556,000 acres are available in Franklin D. Roosevelt Lake. Significant pump lifts, canals, pipelines, and offstream storage would be necessary to provide water supplies to the farms. Some 1,035,000 acre-feet of offstream storage are projected although this could be modified extensively with further analysis of the pump-storage potential adjacent to Roosevelt and Banks Lakes.

In the Okanogan River Basin, about 20,000 acre-feet of upstream storage are required on the first time period to irrigate 13,000 acres. Additional storage, which would involve Canada and require agreements beyond the scope of this report, is not included in the plan. Accordingly, the remaining lands to be irrigated, which amount to 23,000 acres and are in scattered locations along tributary streams, would be supplied about equally from surface and ground-water sources.

The Yakima River Subarea is extensively irrigated with water supplies provided from ground water, natural flows, and about 1,100,000 acre-feet of storage. To meet projected needs, 877,000 acre-feet of new storage would be necessary including 60,000 acre-feet located in Subregion 7. In addition to the reservoir storage, ground-water sources would provide water supplies for 18,000 acres.

Table 24—Planned Irrigation Development, Total Diversions and Depletions, by Subregions and Areas
Columbia-North Pacific Region

Location	1970-1980 *Increment*				1980-2000 *Increment*				2000-2020 Increment				1970-2020 Total			
	New Irrigation	Suppl. Irrigation	Total Diversion	Total Depletion	New Irrigation	Suppl. Irrigation	Total Diversion	Total Depletion	New Irrigation	Suppl. Irrigation	Total Diversion	Total Depletion	New Irrigation	Suppl. Irrigation	Total Diversion	Total Depletion
	(1,000 Ac.)		(1,000 Ac-Ft)		(1,000 Ac.)		(1,000 Ac-Ft)		(1,000 Ac.)		(1,000 Ac-Ft)		(1,000 Ac.)		(1,000 Ac-Ft)	
Area A																
Upper Clark Fork	56	18	168	91	2	0	12	5	15	0	53	34	73	18	233	130
Bitterroot	19	43	57	31	1	0	13	6	1	0	13	7	21	43	83	44
Flathead	100	50	300	162	27	50	83	42	150	27	437	288	277	127	820	492
Lower Clark Fork	32	4	96	51	3	0	9	4	60	0	175	115	95	4	280	170
Kootenai	25	0	75	40	14	0	43	21	46	0	133	88	85	0	251	149
Pend Oreille	16	1	34	21	9	0	19	10	24	0	52	36	49	1	106	67
Spokane	82	2	302	171	34	0	134	72	74	0	266	182	190	2	702	425
Total Subregion 1	330	118	1,032	567	90	50	313	160	370	27	1,130	750	790	195	2,475	1,477
Big Bend Subarea	460	0	2,254	1,008	187	31	976	191	410	0	1,517	723	1,057	31	4,747	1,922
Ferry-Stevens	3	1	12	7	10	0	41	22	10	0	34	23	23	1	87	52
Wenatchee, Chelan, and Entiat	0	5	0	0	0	0	0	0	0	0	0	0	0	5	0	0
Methow Okanogan	13	0	60	34	13	0	62	33	10	0	36	24	36	0	158	91
Total Subregion 2	476	6	2,326	1,049	210	31	1,079	246	430	0	1,587	770	1,116	37	4,992	2,065
Yakima (Subregion 3)	41	88	244	134	20	18	116	59	40	0	152	102	101	106	512	295
Total Area A	847	212	3,602	1,750	320	99	1,508	465	840	27	2,869	1,622	2,007	338	7,979	3,837
Plus Planned Diversion to Snake River Drainage (2000-2020)											565	565			565	565
Total Diversion and Depletion of Upper *Columbia Drainage* Water (2000-2020)											3,434	2,187			8,544	4,402
Area B																
South Fork	-	-	-	-	1	30	32	12	-	-	-	-	1	30	32	12
Henrys Fork	*60*	*3*	*220*	*106*	-	*31*	*23*	*7*	-	-	-	-	60	34	243	113
Heise-Neeley	165	1	535	341	1	6	8	4	61	47	226	145	227	54	769	490
Neeley-Milner	86	81	440	233	108	67	387	257	74	-	238	164	268	148	1,065	654
Northern Streams	56	16	236	145	-	21	17	6	45	-	131	85	101	37	384	236
West Side	68	49	444	217	-	20	25	13	-	-	-	-	68	69	469	230
Total Subregion 4	435	150	1,875	1,042	110	175	492	299	180	47	595	394	725	372	2,962	1,735
Bruneau	*58*	*10*	*245*	*164*	-	-	-	-	340	-	1,360	918	398	10	1,605	1,082
Boise	197	-	749	492	95	-	361	238	-	-			292	-	1,110	730
Payette	77	28	324	209	-	-	-	-	-	-			77	28	324	209
Weiser	1	4	12	7	13	7	60	40	-	-			14	11	72	47
Owyhee	43	10	183	118	10	-	38	25	-	-			53	10	221	143
Malheur	100		380	250	33	-	125	83	-	-			133	-	505	333
Burnt Powder	10	20	58	35	19	63	127	48	-	-			29	83	185	83
Total Subregion 5	486	72	1,951	1,275	170	70	711	434	340	-	1,360	918	996	142	4,022	2,627
Upper Salmon	1	15	27	11	4	41	61	29	-	-	-	-	5	56	88	40
Salmon	-	5	6	3	-	-	-	-	-	-	-	-	-	5	6	3
Clearwater	10	1	41	25	5	-	20	12	5	-	20	13	20	1	81	50
Grand Ronde	40	22	118	81	38	33	113	74	3	-	7	4	81	55	238	159
Palouse-Lower Snake	113	8	442	292	63	2	238	145	212[1/]	-	799	483	388[1/]	10	1,479	920
Total Subregion 6	164	51	634	412	110	76	432	260	220[1/]	-	826	500	494[1/]	127	1,892	1,172
Total Area B	1,085	273	4,460	2,729	390	321	1,635	993	740[1/]	47	2,781	1,812	2,215[1/]	641	8,876	5,534
Less Portion Planned With Columbia River Water (2000-2020)									*150*	*0*	*565*	*565*[2/]	150	0	565	565[2/]
Total Planned With Snake River Drainage Water (2000-2020)									590	47	2,216	1,247[3/]	2,065	641	8,311	4,969[3/]

Area C																
Hood	10	6	-	-	1	0	-	-	3	0	-	-	14	6	-	-
Deschutes	14	3	-	-	19	110	-	-	74	0	-	-	107	113	-	-
John Day	11	12	-	-	11	16	-	-	3	11	-	-	25	39	-	-
Umatilla	131	23	-	-	2	2	-	-	74	3	-	-	207	28	-	-
Walla Walla	66	51	-	-	17	0	-	-	10	0	-	-	93	51	-	-
Northside	75	0	-	-	40	0	-	-	108	0	-	-	223	0	-	-
Total Subregion 7	307	95	1,537	827	90	128	410	200	272	14	1,006	599	669	237	2,953	1,626
Total Subregion 9	186	26	589	325	420	0	1,034	657	150	0	268	213	756	26	1,891	1,195
Rogue	32	8	-	-	0	0	-	-	7	4	-	-	39	12	-	-
Umpqua	23	1	-	-	1	0	-	-	4	4	-	-	28	5	-	-
Coastal	11	1	-	-	3	0	-	-	11	0	-	-	25	1	-	-
Total Subregion 10-S	66	10	244	140	4	0	8	5	22	8	72	47	92	18	324	192
Ft. Rock	7	14	-	-	20	20	-	-	0	0	-	-	27	34	-	-
Silvies	0	55	-	-	0	62	-	-	0	0	-	-	0	117	-	-
Alvord	0	8	-	-	14	37	-	-	0	0	-	-	14	45	-	-
Total Subregion 12	7	77	116	71	34	119	256	154	0	0	0	0	41	196	372	225
Total Area C	566	208	2,486	1,363	548	247	1,708	1,016	444	22	1,346	859	1,558	477	5,540	3,238
Area D																
Lewis River	35	-	87	59	10	-	22	15	0	-	0	0	45	-	109	74
Cowlitz River	0	-	0	0	0	-	0	0	30	-	81	54	30	-	81	54
Columbia River (Oregon)	3	-	7	4	0	-	0	0	0	-	0	0	3	-	7	4
Total Subregion 8	38	-	94	63	10	-	22	15	30	-	81	54	78	-	197	132
Chehalis River	31	-	62	44	4	-	7	5	11	-	30	20	46	-	99	69
Willapa	5	-	7	4	0	-	0	0	0	-	0	0	5	-	7	4
Coastal Drainages	3	-	5	3	2	-	3	2	5	-	8	5	10	-	16	10
Total Subregion 10N	39	-	74	51	6	-	10	7	16	-	38	25	61	-	122	83
Nooksack-Sumas	14	-	33	25	20	-	38	26	0	-	0	0	34	-	71	51
Skagit-Samish	7	-	13	13	10	-	19	18	25	-	48	47	42	-	80	78
Stillaguamish	3	-	6	4	4	-	8	5	0	-	0	0	7	-	14	9
Snohomish	1	-	2	1	4	-	7	5	1	-	3	2	6	-	12	8
Cedar-Green	(-1)	-	(-2)	(-1)	(-1)	-	(-2)	(-1)	0	-	0	0	(-2)	-	(-4)	(-2)
Puyallup	2	-	5	3	5	-	12	8	3	-	6	4	10	-	23	15
Nisqually-Deschutes	2	-	5	3	5	-	12	8	8	-	19	12	15	-	36	23
West Sound	0	-	0	0	1	-	1	1	0	-	1	1	1	-	2	2
Elwha-Dungeness	6	-	(-15)	(-15)	0	-	0	0	0	-	0	0	6	-	(-15)	(-15)
Total Subregion 11	34	-	47	33	48	-	95	70	37	-	77	66	119	-	219	169
Total Area D	111	-	215	147	64	-	127	92	83	-	196	145	258	-	538	384
REGIONAL TOTALS	2,609	693	10,763	5,989	1,322	667	4,978	2,566	1,957	96	7,192	4,438	5,888	1,456	22,933	12,993

1/ Includes 150,000 acres developed with Columbia River water with diversions of 565,000 acre-feet and depletions of 341,000 acre-feet.
2/ includes 341,000 acre-feet depletion of Columbia River water plus 224,000 acre-feet of return flow to Snake River drainage.
3/ Represents net depletion of Snake drainage water supply at mouth of Snake River.

Much of the additional irrigation projected for the Upper Snake Subregion would depend on a combination of new storage on the Snake River or its major tributaries and pumping from the Snake Plain Aquifer. Companion to this would be replacement of irrigation storage in Jackson Lake to enhance the lake's recreational and esthetic aspects. Although many suitable storage sites have been identified and the combined surface and ground-water resources are adequate, more detailed studies are required to determine the proper combination.

Most irrigation development in the South Fork Subarea is scattered along mountain valleys and depends largely on unregulated runoff. Consequently, some 113,000 acres of presently irrigated land are short of late-season water. A minor amount of additional storage plus special water conservation measures would permit furnishing supplemental water to about 30,000 acres of water-short land and the development of 1,200 acres of new irrigation.

The 60,000 acres of new irrigation projected for the Henrys Fork Basin could be supplied mostly from storage under construction on the Teton River, from natural flow, and from ground water. A small amount of new storage would also be required on tributaries of Henrys Fork. Supplemental water could be supplied to 34,000 acres of presently irrigated land.

Typical water-short land in southern Idaho (USBR).

In the Heise-Neeley Subarea, nearly 227,000 acres of new irrigation could be developed and the supply to almost 54,000 water-short acres firmed up. Ground water could supply 202,000 acres of new land, tributary storage could supply nearly 2,000 acres of new land and 7,000 acres of supplemental irrigation. In the Fort Hall area, some 13,000 acres of new irrigation would be developed from existing surface supplies. A combination of tributary storage, natural flow, and exchange ground-water pumping could support nearly 10,000 acres of new land and 47,000 acres of water-short land.

New irrigation on nearly 269,000 acres and supplemental water for over 148,000 acres could be provided in the Neeley-Milner Subarea. Almost 267,000 acres of new irrigation and 120,000 acres of supplemental lands on the Oakley Fan and in the Raft River drainage could be supplied by using a combination of Snake River flows and storage, exchange ground water and local ground water. Small tributary storage and Snake River flows could supply the remainder.

In the Northern Streams sector water could be supplied to nearly 37,000 acres of water-short lands and over 100,000 acres of new land. Ground water could supply 94,000 acres of the new land and over 13,000 acres of water-short land; the remainder could be supplied from small tributary storage.

Development in the West Side Subarea could irrigate nearly 68,000 acres of new land and supplement supplies for almost 70,000 acres. Some 45,000 acres of new irrigation in the Salmon Falls and Deep Creek areas could be supplied from Snake River storage, exchange ground-water pumping, and local ground water. These same sources could supplement supplies for over 49,000 acres south of the Snake River. Ground water could be used to supplement supplies to 15,000 acres in the Big Wood drainage. Some 5,000 acres would receive supplemental supplies from small tributary storage.

In the Bruneau Subarea, 398,000 acres of new irrigation could be developed and the supply firmed up on 10,000 water-short acres. Pumping from the Snake River and ground water could be used for 116,000 acres of new land; the remaining 282,000 acres could be supplied by pumping some half-million acre-feet of excess Snake River flows to offstream storage. Storage on Succor Creek could supply the supplemental lands.

Some 292,000 acres of dry land on the Mountain Home Plateau in the Boise Subarea could be irrigated by a water exchange involving the Payette, Boise, and Snake Rivers and the construction of 2.4 million acre-feet of storage on the South Fork Payette River at the Garden Valley site.

In the Payette Basin, some 67,000 acres of new irrigation could be served primarily from existing storage. An additional 10,000 acres could be developed in the upper basin using 62,000 acre-feet of storage on Gold Fork; this storage could also supplement supplies to 28,000 water-short acres.

Small tributary storage and enlargement of Lost Valley Reservoir could irrigate 14,000 acres of new land and supplement supplies to 11,000 acres in the Weiser Basin.

In the Owyhee Basin, some 53,000 acres west of the Owyhee Project and south of Vale would be irrigated by pumping a combination of ground water and Snake River flows; offstream storage would be required. Storage on Jordan Creek would make supplemental water available to 10,000 acres in Jordan Valley.

In the Malheur Basin, some 113,000 acres of new land would be irrigated by pumping from the Snake River; 20,000 acres would be developed from local ground water.

Small reservoirs in the Powder and Burnt River Basins would furnish supplemental water to some 83,000 acres and permit the development of 29,000 acres of new land.

Small tributary storage in the Upper Salmon River Basin could permit development of about 1,000 acres of new land and supplement supplies to over 17,000 acres of water-short lands. Supplemental water for 39,000 acres plus the irrigation of nearly 4,000 acres of new land would be accomplished with ground-water pumping. No additional new irrigation is anticipated in the remainder of the Salmon River drainage, but supplemental supplies are expected to be developed privately from ground water for the 5,000 acres of the water-short land.

Irrigation of some 16,000 acres of new land plus minor supplemental irrigation is expected in the Clearwater Basin by pumping from the Snake River. Small tributary storage could be used to supply an additional 4,400 acres of new land.

Two authorized reservoirs in the Grande Ronde Subarea will store 220,000 acre-feet. These, together with several new small reservoirs, would irrigate over 76,000 acres of dry land and provide supplemental water to 52,000 acres of water-short land. An additional 5,200 acres of new irrigation and 3,000 acres of supplemental irrigation are expected to be served from ground water.

In the Palouse-Lower Snake Subarea, some 150,000 acres would be irrigated by diversion from the Columbia River. The remaining 238,000 acres of new land would be served from numerous small reservoirs and pumping from the Snake River and ground water; these same sources would supply supplemental water to over 10,000 water-short acres.

In Subregion 7 (Mid Columbia) irrigation development would be primarily by major Federal and federally assisted projects in the Umatilla, Deschutes, Walla Walla, and White Salmon River Basins and along both sides of the Columbia River. Water supplies for these projects would be provided from storage and

from Columbia River streamflow. Some private development is anticipated adjacent to Columbia River by river pumping and at other locations in the subregion wherever ground-water pumping or farm pond construction is practical. Supplemental water supplies could not be provided to 14,000 acres of inadequately irrigated lands in the John Day Basin; consequently the plan includes irrigation of 1,800 acres of new lands additional to subregion projections.

In Subregion 9 (Willamette) irrigation would be a mixture of private, Federal, and federally assisted developments. More than two-thirds of the water for irrigation would be supplied from existing and new reservoirs on about an equal basis; the remainder would come from ground water, farm ponds, and natural flows. With only minor exceptions, new storage is proposed to irrigate only those lands which cannot be supplied economically from existing and authorized reservoirs.

In Subregion 10S, especially in the Rogue and Umpqua drainages, future irrigation would rely almost entirely on storage because existing streamflows are already fully appropriated during the irrigation season and ground-water supplies are limited. About 41 percent of the new irrigation would be in the Rogue Basin with the Umpqua and Coastal Basins accounting for the remaining 32 and 27 percent, respectively. Supplemental water supplies could not be provided to about 29,000 acres; consequently, the plan includes irrigation of about 7,000 acres of new lands in lieu of the supplemental water needs.

Future irrigation development of new lands by private and federally assisted projects is planned in the western and southeastern portion of Subregion 12, the Oregon Closed Basin. Also a major portion of its inadequately

This scene on U. S. Highway 395 near Wagontire in the northwestern part of the subregion is typical of the Oregon Closed Basin (Oregon State Highway Commission).

irrigated lands would be provided a supplemental water supply. Water supplies for new and supplemental lands would be provided from ground water and storage of streamflows on a ratio of about two-thirds and one-third, respectively. In the Silvies River Basin, future irrigation water supplies would be drawn primarily from ground water on an interim basis to lessen the possible adverse impact on Malheur Lake until completion of studies to more adequately define the potential impact of surface and ground-water development. Supplemental water supplies could not be provided to about 82,000 acres, consequently, the plan compensates by providing irrigation of about 28,000 acres of new lands.

In the Lewis and Cowlitz River drainages of Subregion 8 nearly all irrigation development would be located along the lower river valleys. About 150,000 acre-feet of storage would be needed in the Lewis River-Salmon Creek drainages and 35,000 in Cowlitz. The water supplies for other lands would be obtained by pumping from ground water or direct diversion from tributary streams and the Columbia River.

Irrigation in the Chehalis River Basin would be supplied water from a 60,000 acre-foot reservoir, tributary stream diversion, and ground-water pumping.

A portion of the water from a 90,000 acre-foot multiple-purpose reservoir in the lower Willapa River drainage would be the source of supply for 5,000 acres of projected irrigable lands. The remaining lands to be irrigated are located in small parcels along the coastal drainages and would obtain their water supplies from local ground-water aquifers.

In the Puget Sound Subregion, future irrigation development would be accomplished primarily by individual farm developments except for parts of the Nooksack and Skagit-Samish River Basins where project-type developments are expected. Water supplies for the individual farm developments would be obtained primarily from ground water supplemented by surface diversions from the major rivers and tributary streams. All the river basins would have a net increase in irrigated land except for Whidbey, Camano, and the San Juan Islands, which are planned to remain at current levels of development, and the Cedar and Green River Basins where a net reduction is expected due to urban and industrial growth onto the agricultural lands.

In summary, no attempt was made to estimate the increase in new irrigation required in Area B (Subregions 4 and 5) to compensate for the inability to supplement water supplies for 389,000 water-short acres. An undetermined amount of this shortage could be made up by increased onfarm efficiency and water savings. However, most of the lack of production would have to be compensated for by additional new irrigation, if not in the Snake River Basin, then in some other part of the region where there are ample supplies of water and irrigable land. An extra 1,000 acres of new irrigation were included in Area B to partially make up for the shortage.

In Area C (Subregions 7, 9, 10S, and 12), a practicable supplemental supply could not be identified for some 125,000 acres of water-short land. However, there are additional irrigable lands in the area for which water could be provided. It was estimated that the production deficiency could be made up by irrigating 37,000 acres of dry land. This additional new irrigation was included in the plan and accounts for most of the apparent excess of new irrigated land.

Although the plan does not include sufficient irrigation development to fully meet projected food and fiber needs, there is ample land and water available to satisfy both the economic efficiency objective and the regional development objective when the additional amount is determined.

The environmental quality objective was considered throughout the formulation of plans to meet the irrigation need. Both positive and negative effects are inherent in any development. In areas of high scenic and recreation value, such as the Jackson Hole-Teton-Yellowstone and Salmon-Clearwater areas, development would be minimized. Developments on potential wild and scenic rivers would be avoided until studies of the potentials are completed. Where storage would be required, additional capacity would be included to alleviate flooding and to improve low flows and their quality. However, some storage and diversions could reduce streamflows to less than optimum, inundate prime stream fisheries, block wildlife migration routes, or flood out critical winter habitat. However, irrigation developments would incorporate green belts along wasteways, laterals, canals, property lines, roadways, and stream courses and preservation of blocks of land and project-caused wetlands for wildlife management or preservation of indigenous species. Such development would allow the retention of some wildlife values and provide for food and fiber needs. New storage also would provide additional lake-type fishery and additional recreation water surface.

Irrigation needs and plan accomplishments are compared in table 25.

Table 25—Irrigation Needs and Plan Accomplishments
Columbia-North Pacific Region

Item	1970-1980	1980-2000	2000-2020	Total
		(1,000 acres)		
Needs				
New	2,595	1,298	2,107	6,000
Supplemental	1,970	0	0	1,970
Plan Accomplishments				
New	2,609	1,322	2,107	6,038
Supplemental	693	667	96	1,456
Difference				
New	+14	+24	0	+38
Supplemental 1/	-1,277	+667	+96	-514

1/ Minus values represent acres of land deficient in water.

Multiple-Purpose Reservoir Storage

Almost every major stream is controlled to some degree by storage dams. There are 194 reservoirs with storage capacities of 5,000 acre-feet or more with a combined active storage volume of 40 million acre-feet. In addition, about 26,000 small reservoirs of lesser size store 400,000 acre-feet.

Figure 30 illustrates the distribution of planned multiple-purpose reservoir storage by time periods in the four areas. The total additional storage by 2020 could be about 17 million acre-feet. In most cases, the storage would provide water supplies for irrigation, control floods, provide municipal and industrial water supplies, furnish water bodies for general recreation and fishing, and increase low streamflows to improve esthetics, water quality, and fish habitat. This storage is further broken down in table 26 by area, subarea, or river basin by time period and purpose. About one-third of this potential storage lies in river basins or subareas which require further study to select the best plan from an array of alternatives. Some of those sites are highly controversial because of their environmental impact.

Each element of storage is further described in the subsequent narrative.

In the upper Clark Fork Basin, storage for irrigation and other incidental uses would be from reservoirs of 2,000 to 6,000 acre-feet capacity in small tributary watersheds, and one of approximately 60,000 acre-feet capacity.

Storage in the Bitterroot Basin could be obtained by enlarging existing reservoirs at Lake Como, Burnt Fork, and West Fork. This storage would supply irrigation; augment low flows for water quality, aquatic life, and recreation; aid in flood control; and improve the reservoirs for recreation use.

About 9,000 acre-feet of storage would be required in the Flathead Basin to assure a full supply of irrigation water. This would be available from small watershed reservoirs.

A reservoir on the Coeur d'Alene River in the Spokane Basin to provide recreation, augment low flows for esthetics, irrigation, water quality, and fisheries, and control flows for downstream flood protection would be constructed contingent on the findings of further studies.

Storage on Crab Creek would provide irrigation water supply; flood protection; flow augmentation for esthetics, fish and wildlife, and water quality; and reservoir recreation. Additional offstream storage in the Big Bend area would permit a greater flexibility to future irrigation development of this area and, at the same time, provide fish, wildlife, and recreational values. Opportunity exists for using some of this storage in conjunction

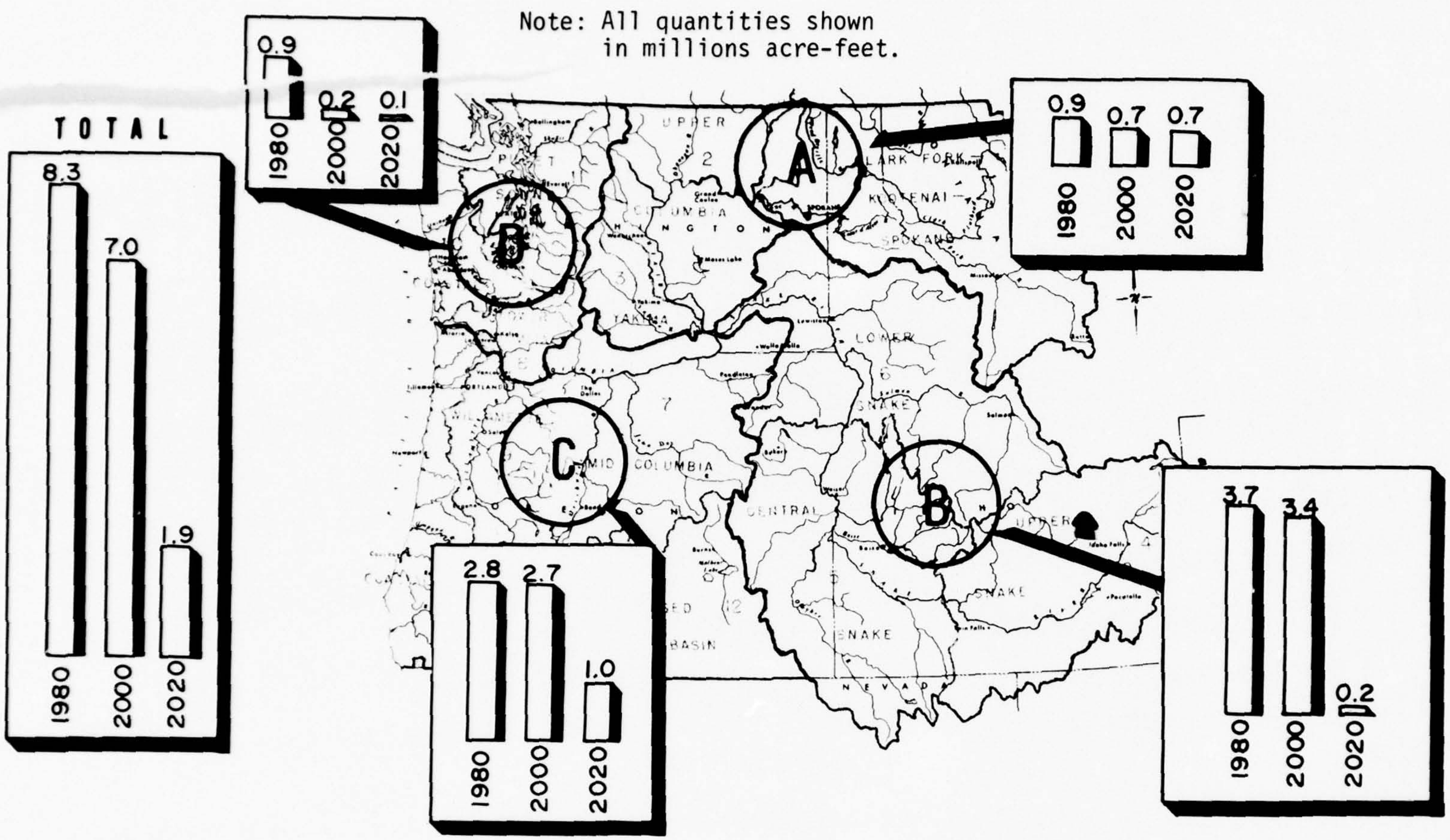


FIGURE 30. Additional Major Reservoir Storage

Table 26—Planned Major Reservoir Storage
Columbia-North Pacific Region

Location	Increments of Storage 1970-1980	1980-2000	2000-2020	Total	Purpose[1]
	(1,000 ac-ft)				
Area A					
Upper Clark Fork	100	0	11	111	I, F, R
Bitterroot River	33	0	0	33	I, F, FC, R
Flathead River	0	9	0	9	I, F, R
Spokane River	0	150	5	155	I, WQ, FC, R
Big Bend	0	485	550	1,035	I, WQ, F, FC, R
Methow-Okanogan	20	0	0	20	I, F, R
Yakima River	722	55	100	877	I, WQ, FC, F, R
Area A TOTAL	875	699	666	2,240	
Area B					
South Fork	0	1,650		1,650	I, FC, R, P, F, W
Henrys Fork	10	4	0	14	I, R
Heise-Neeley	12	74	0	86	I, FC, R
Neeley-Milner	0	19	0	19	I, R, FC
Northern Streams	24	20	0	44	I, R
West Side	0	9	0	9	I, FC, R
Bruneau	15	500	0	515	I, FC, F, R, W
Boise	335	601	1	937	I, FC, P, R, WQ
Payette	2,462	0	0	2,462	R, FC, I, P
Weiser	29	68	3	100	I, FC, R
Owyhee	107	0	0	107	I, FC, R
Malheur	81	57	0	138	I
Burnt-Powder	50	26		76	I, FC, R
Upper Salmon	11	22	0	33	I, FC, R, F, WQ
Salmon	0	0	0	0	
Clearwater	18	40	1	59	I, R, FC
Grande Ronde	270	200	0	470	I, FC, F, R, M, WQ
Palouse-Lower Snake	250	76	150	476	I, FC, R
Area B TOTAL	3,674	3,366	155	7,195	
Area C					
Subregion 7, Mid Columbia	(964)	(502)	(272)	(1,738)	
Hood	58	-	5	63	I, FC, M&I, R, F
Deschutes	32	408	106	546	I, FC, M&I, R, F
John Day	40	94	19	153	I, FC, M&I, R, F
Umatilla	468	-	-	468	I, FC, M&I, R, F
Walla Walla	260	-	81	341	I, FC, M&I, R, F, WQ
Northside Columbia	106	-	61	167	I, FC, M&I, R, F
Columbia River	-	-	-	-	I, FC, M&I, R, F
Subregion 9, Willamette	933	1,282	701	2,916	I, FC, M&I, R, F, WQ, N, P
Subregion 10-S, Coastal	(858)	(803)	(29)	(1,690)	
Rogue	738	3	-	741	I, FC, M&I, R, F, P
Umpqua	103	625	7	735	I, FC, M&I, R, F
Coastal	17	175	22	214	I, FC, M&I, R, F
Subregion 12, Closed Basin	(14)	(111)	-	(125)	I, FC, M&I, R, F
Ft. Rock, Christmas L. & Chawaucan	14	37	-	51	I, FC, M&I, R, F
Silvies R., Silver Cr., Donner and Blitzen	-	9	-	9	I, FC, M&I, R, F
Alvord, Catlow, & Warner Lakes	-	65	-	65	I, FC, R, F
Area C TOTAL	2,769	2,698	1,002	6,469	
Area D					
Subregion 8					
Salmon Creek	150[2]	0	0	150	I, M&I, R, FC
Cowlitz River	0	0	35	35	I, FC, R
Subregion 10N					
Chehalis River	60	0	0	60	I, M&I, FC, R
Willapa River	90	0	0	90	I, M&I, F, FC, R
Subregion 11					
Nooksack	63	21	-	84	M&I, FC, R, F, I, P
Skagit	-	134[2]	-	134	P, FC, F, R, WQ
Snohomish	434	15	-	449	FC, R, F, P
Cedar	50			50	M&I, FC
Puyallup	-	24	-	24	FC, P, R, I, M&I
Deschutes	-	-	15	15	FC, R
Area D TOTAL	847	194	50	1,091	

1/ I-Irrigation; FC-Flood Control; F-Fish; M&I-Municipal & Industrial; P-Power; R-Recreation; WQ-Water Quality; N-Navigation.
2/ Optional.

with potential pumped-storage operation at Banks and Roosevelt Lakes, and/or thermal power generation. These possibilities must be examined in greater detail before decisions can be made as to the best plan.

Storage in the Okanogan River Basin would provide irrigation, water supply, reservoir recreation, and fishing opportunities. Any additional storage would be dependent on the results of joint studies with Canada.

Multiple use of the 1.07 million acre-feet of existing storage space and provision of 877,000 acre-feet of additional storage in the Yakima Basin would provide additional irrigation water, flow augmentation for fish and water quality enhancement, and flood control. The final location use and size of storage is dependent on a plan to be selected by more detailed interdisciplinary studies.

In the South Fork Subarea of Area B, three small reservoirs could provide storage for irrigation and flood control. Major storage of approximately 1.6 million acre-feet, at one or more sites on the Snake River or its major tributaries, could provide replacement storage for Jackson Lake and essentially complete control of the upper Snake River for power generation, and downstream irrigation, flood control, water quality, and fish life. The location and size of this storage will require further study.

With completion of Teton Dam, only small tributary storage is required in the Henrys Fork Basin for irrigation, flood control, and recreation.

If new major storage were provided above Heise, the need for new storage in the Heise-Neeley-Milner part of the area would be reduced to that which can be furnished by small tributary stream reservoirs, the largest having 70,000 acre-feet of capacity. These reservoirs could furnish water for flood control, irrigation, and recreation.

Small reservoirs in the Northern Streams and West Side Subareas could provide irrigation and flood control storage plus some recreation; the largest would store only 24,000 acre-feet.

A major offstream reservoir of about one-half million acre-feet in the Bruneau Subarea could be used to store primarily floodflows pumped from the Snake River for irrigation purposes. This reservoir could also help meet recreation, fish, and wildlife needs. One other 15,000 acre-feet reservoir could be used for irrigation, flood control, and recreation.

Major storage is required in the Boise River drainage for flood control purposes. Although the framework study identifies 600,000 acre-feet at the Twin Springs site principally for this purpose, there would be major conflicts with wildlife and recreation requiring further study before the acceptability of this storage could be determined Such storage could also provide hydropower, lake-type recreation, and flows for water quality. A run-of-the-river

power development on the Snake River in the Guffey-Swan Falls reach with some 120,000 acre-feet of storage would also provide recreation and reduce irrigation pump lifts. Four small flood detention reservoirs should be constructed in minor canyons on the north side of Boise to protect the city.

Additional storage of 2.4 million acre-feet on the South Fork Payette River could be used for flood control, for power, and for irrigation in the Boise Subarea. One other reservoir of 62,000 acre-feet in the Payette Basin could furnish flood control, recreation, and an irrigation water supply.

Storage of about 100,000 acre-feet in the Weiser Basin could be obtained by enlarging Lost Valley Dam, constructing Tamarack Valley Dam, and building additional reservoirs. These reservoirs could supply irrigation water, furnish recreational opportunities, control flooding, and enhance the fishery.

Storage of 65,000 acre-feet on Jordan Creek for flood control, recreation, and irrigation, and 42,000 acre-feet of offstream storage near Vale for irrigation are the only reservoirs included in the plan for the Owyhee Basin. The Malheur Basin would also require offstream irrigation storage at two sites with a total of 81,000 acre-feet.

Five small reservoirs in the Burnt and Powder Basins would store a total of 76,000 acre-feet for irrigation, flood control, and recreation.

The study identified five small reservoirs with a total of 33,000 acre-feet for the Upper Salmon Basin to satisfy irrigation, flood control, recreation, and fishery water needs. No storage is included for the remainder of the Salmon River Basin.

In the Clearwater Basin, seven small reservoirs, located on tributary streams, could serve irrigation, recreation, and flood control with some 59,000 acre-feet of capacity.

Some 220,000 acre-feet of the 470,000 acre-feet of storage required in the Grande Ronde Subarea would be provided by two authorized projects, one on the Grande Ronde River and one on Catherine Creek. Eleven other small reservoirs are also included for minor tributary streams. Principal functions to be served are flood control, irrigation, municipal water supply, recreation, water quality, and fish.

Numerous small reservoirs are needed in the Palouse-Lower Snake Subarea for flood control, irrigation, recreation, and sediment retention. The total storage capacity of the 49 reservoirs would total 476,000 acre-feet.

In Subregion 7 of Area C, 57 reservoirs with capacities ranging up to 200,000 acre-feet would provide the planned storage. Most of the storage would be in the Deschutes, Umatilla, and Walla Walla River Basins. In the Deschutes River Basin, reservoirs are planned primarily to provide

attractive water bodies for recreation and fishing and to allow a moderate expansion of irrigation without reducing streamflows during the low flow season. In the Umatilla and Walla Walla River Basins, future irrigation and flood control needs are more critical; consequently, a greater percentage of the storage would be for these purposes than in the Deschutes Basin. Water quality control is also an important purpose of Walla Walla Basin storage because, even with projected improvements in waste treatment, flow augmentation is necessary during critical periods. The John Day River Basin has great potential for anadromous fish production; consequently, a major purpose of storage in that basin is to improve low streamflows for the enhancement of anadromous fish runs. In the Hood and Northside Columbia Basins storage is planned primarily for irrigation with benefits accruing to most other functions as well.

The Willamette portion of the plan includes almost 3 million acre-feet of storage in 93 new storage reservoirs, plus modification of one existing reservoir and rescoping of one authorized reservoir. The projects range in size from 1,000 acre-feet to more than 270,000 acre-feet, most of which are small watershed projects scattered throughout the basin. The larger new projects would generally be located in the western and northern portions of the subregion because previous reservoir construction has met the majority of needs in the southern and eastern portions. Reservoir projects would be multiple purpose in scope, typically providing flood protection and water for irrigation, recreation, and fish. In particular situations, the storage would also be used for municipal and industrial water supply, water quality control, navigation, and electric power production.

In Subregion 10S the plan includes about 1.7 million acre-feet of storage in 19 new reservoirs which range in size from 200 acre-feet to 480,000 acre-feet. The two largest reservoirs would be located on the Rogue and South Umpqua Rivers with the remainder of the storage in small to medium-sized reservoirs scattered over the subregion. Flood control would be a major function of most of the reservoirs as previous construction of reservoirs has been limited, and most streams are essentially uncontrolled. Other typical uses of the storage would be for municipal, industrial, and irrigation water supply, water quality control, general recreation, and fish production. In the Rogue River Basin, the storage would also be used for electric power production.

The plan includes only 125,000 acre-feet of storage in the Oregon Closed Basin, Subregion 12. The storage would be contained in 11 relatively small multiple-purpose reservoirs, all of which would be constructed prior to 2000. In the interest of maintaining Malheur Lake in its present state, no storage is planned on the Silvies River until adequate identification of potential impacts of such storage. However, 9,300 acre-feet are planned on tributaries of Silver Creek which drains into Harney Lake.

Storage in the Cowlitz River Basin, a portion of Area D, would provide the supply for a portion of the irrigation needs. A storage reservoir in the

Salmon Creek area would provide 150,000 acre-feet of water for multiple-purpose use in the Vancouver area of southwest Washington. Alternatives include ground-water development, pumping from the Columbia River, and offstream storage.

On the Chehalis River, the multipurpose reservoir at Doty would provide storage for irrigation, flood control, and municipal and industrial waters for the Centralia-Chehalis service area. An alternative long-range plan includes the Alpha Dam and Reservoir to provide about 30,000-35,000 acre-feet of multiple-purpose storage in the upper Chehalis Basin. However, this alternative was not included in the plan as irrigation water is programmed to be supplied from ground-water sources in lieu of storage.

Along the coast the multiple-purpose Willapa project would provide storage for irrigation, fishery, and municipal and industrial uses. This reservoir would also provide flood control.

Multiple-purpose storage at various sites in Subregion 11 is planned to provide the irrigation water supply, flood protection, reservoir recreation, and flow augmentation for esthetics, water quality, and fish and wildlife uses. By 1980 approximately 547,000 acre-feet of new storage would be developed at five sites of which 383,000 acre-feet would contribute to flood control; all of the storage would be used for other purposes. In addition 155,000 acre-feet of flood control storage would be obtained by changing the existing operation of electric power reservoirs at two locations. During the later time periods, 209,000 acre-feet of storage at five sites would be made available, including the Lower Sauk project in the Skagit River Basin. Without this project, the total storage would be 75,000 acre-feet.

Fish and Wildlife

The sport fishing needs are projected to increase from about 21 million angler days in 1970 to about 32 million per year by 1980, 45 million by 2000, and 64 million by 2020. This includes recreational use of anadromous, resident, marine, and shellfish species. Commercial harvest of anadromous and marine fish and shellfish is projected to increase to about 270 million pounds by 1980, 357 million by 2000, and 467 million by 2020. Hunter days are projected to rise from about 10.5 million in 1970 to more than 23.6 million by 2020.

In order to satisfy future needs, the plans and programs would be oriented largely toward preserving and upgrading the available habitat and improving sportsman access to it. A considerable amount of habitat preservation is included in the recreation program of studies to identify land and streams which should be preserved in their natural condition. Habitat preservation in other areas would be accomplished, as provided in the plan for other functions, by avoiding developments, to the extent possible, in prime or

critical fish and wildlife areas. In addition to the satisfaction of hunting and fishing needs, the plan elements for preservation and protection of fish and wildlife include the preservation of rare and endangered species.

Fish

The framework plan recommends that nearly 14,000 miles of streams, identified on figure 31, be considered for protection of fish habitat to retain quality angling. Preservation measures should include maintenance of proper flows, optimum water quality, and related physical characteristics, including pools and riffles, meanders, bank vegetation, and bottom materials. Accomplishing this goal would require proper watershed management such as protection from improper channeling, gravel removal, waste disposal, livestock grazing, and other conflicting factors.

The coastal subregion contains many estuarine areas which provide large amounts of outdoor recreation compatible with sport and commercial fisheries. Pollution, dredging, and filling have had detrimental impacts on many of them from the standpoint of recreational and commercial use of fish and shellfish. The remaining estuarine habitat should be protected, and comprehensive plans designed to permit urban-industrial development and other uses only where they are found to be compatible with these resources. Such a plan has been prepared for Yaquina Bay, Oregon, and similar plans are needed for the following estuarine areas:

Washington	Oregon
Columbia River mouth	Rogue River estuary
Willapa Bay	Coquille River estuary
Grays Harbor	Coos Bay
Puget Sound Area	Winchester Bay
	Siuslaw Bay
	Alsea Bay
	Siletz Bay
	Salmon River estuary
	Nestucca Bay
	Sand Lake
	Netarts Bay
	Tillamook Bay
	Nehalem Bay
	Youngs Bay
	Columbia River mouth

A variety of improvement measures would help expand the habitat base. Stream barriers, such as logjams and impassable falls and culverts, would be removed or fish passage facilities provided to increase the amount of spawning area available to anadromous fish. Water pollution should be abated and

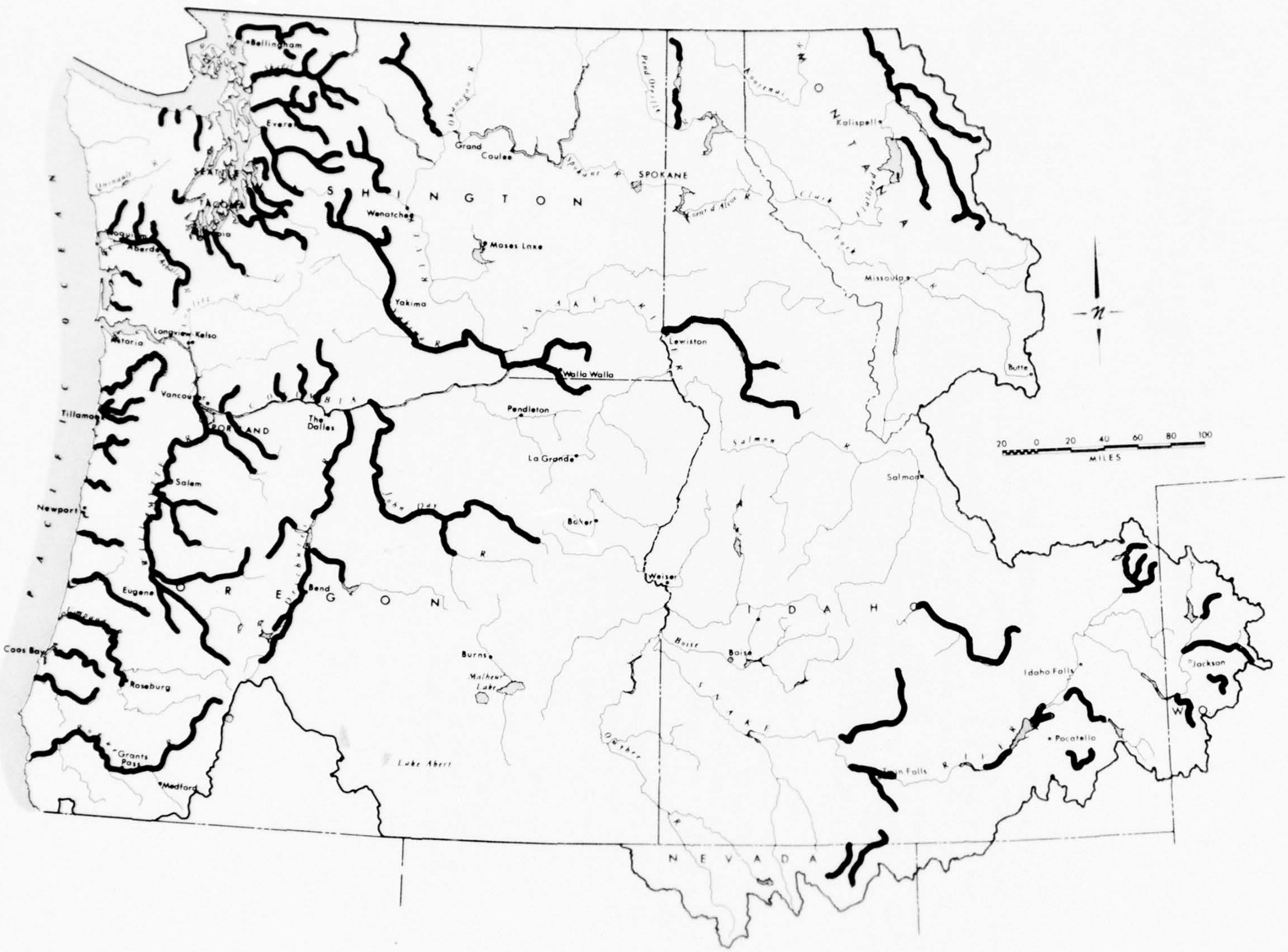


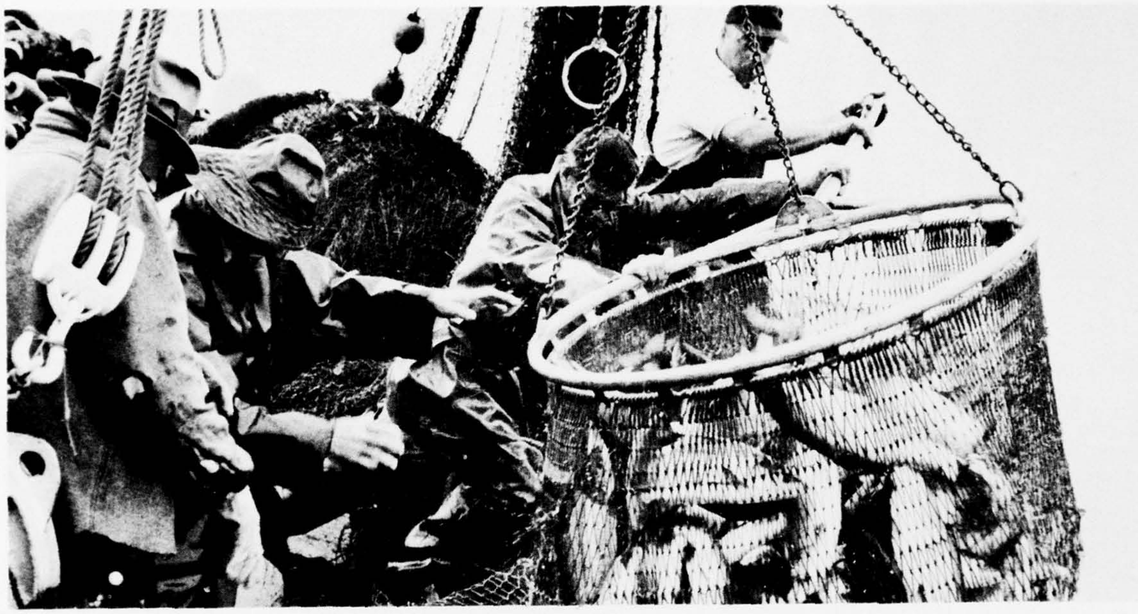
FIGURE 31. Streams to be Considered for Protection and Enhancement of Fish Habitat

Logging waste and erosion can block fish movement and hinder angler use (Oregon State Game Commission).

streamflows increased or regulated on many streams to restore, improve, or maintain habitat. In some subregions, small fishing impoundments should be constructed where they would not eliminate existing stream fisheries or wildlife values. Other measures that should be implemented where appropriate include: chemical control of undesirable fish, development of spawning beds in streams, fertilization of some lakes, introduction of beneficial aquatic plants and food organisms, installation of gradient reducing devices, construction of fish shelters, removal of debris, and control of aquatic weeds. Habitat improvement of about 33,000 miles of stream and 422,000 acres of lake surface are listed by area and time period in table 17, and broken down by subregion in tables 18 through 21.

Increasing the harvest of fish and shellfish through improved access to streams, lakes, and salt water areas could do much to satisfy projected needs. The program to improve fishing access includes almost 10,000 miles of stream, plus about 1,400 lakes access sites, and 400 salt water access sites. Many of the lakes and streams are presently accessible, but access areas need to be modified or enlarged to accommodate future needs. Warm water fish populations which have a capacity for significant increased use, would satisfy needs through 2020 with the present level of management.

One of the primary means for increasing production of fish would be artificial propagation. Hatcheries, incubation channels, and spawning



Harvesting pink salmon from the waters of Puget Sound (Washington Dept. of Fisheries).

channels will become more and more important as the demand increases. Spawning channels have had limited success; however, studies may suggest methods to improve production and indicate species most conductive to this type of management. Incubation channels can contribute significantly to fish populations. Increased production in existing hatcheries could be accomplished through water reuse, controlled environment, improved feeds, disease abatement, and many other techniques. A total of 144 new or expanded hatcheries and nearly 11,000 acres of additional small rearing ponds would be a part of the plan.

In Subregion 2, possible areas for rearing salmon and steelhead smolts are: the lower Crab Creek area, Priest Rapids area, Quincy Game Range area, and areas along the Methow and Wenatchee River systems. Areas for rearing salmon and steelhead in Subregion 3 include an abandoned irrigation canal on the Yakima River near Richland, Richland and Barker ponds on the Yakima River at Richland, and Horseshoe pond on the Yakima River near Mabton.

Generally in the Snake River area, considerable additional fishing pressure and harvest could be met without serious reduction in fishing quality. The critical portion of the area is in Subregion 5, where, except for alpine lakes, most waters are receiving heavy fishing use, and accessible trout streams require maintenance stocking of hatchery fish. Also, the introduction of kokanee and coho in large reservoirs and channel catfish in the Snake River above C. J. Strike Dam would provide additional supplies. Additional nongame fish control would also be important.

Wildlife

Wildlife needs would be met by the acquisition of more than 3-3/4 million acres of land in fee or by easement, habitat improvement on about 10 million acres, and improved access to about 60 million acres for hunting. The upland bird supply would be augmented by game farm rearing of 680,000 birds. These wildlife measures are also tabulated by area, subregion, and time period on tables 17 through 21.

The region contains considerable land that is closed or subject to closure to hunters. In addition, a substantial amount of huntable land receives less than maximum use because of remoteness or lack of facilities such as roads, camping areas, etc. Although several thousand acres probably fall in this category, studies are needed to determine specific access requirements and hunting potential. Special studies are also needed to determine conflicts between wildlife and other uses where hunting would be itensified; quality versus quantity of hunting must also be appraised.

Wildlife habitat preservation, enhancement, and harvest requirements would be better identified following development of big game range analysis and upland game habitat management plans. These, scheduled in the 1970 to 1980 time period, are additional to ongoing priority game and habitat surveys conducted by resource management agencies.

Also included in the framework plan is a recommendation for special hydrologic studies of water quality and quantity in the Malheur Lake area. This study should be initiated as soon as possible to determine the surface-ground water relationship, the effect of withdrawals upon the natural marsh in Malheur Lake, and the wildlife production of the Malheur National Wildlife Refuge, and lastly, water necessary for optimum wildlife production and enhancement without degradation of the marsh environment.

Planned fish and wildlife land and water requirements are shown in table 27. No procedure was devised for making a comparison between needs, in terms of pounds of fish or sportsman-days, and the elements included in the plan. However, in the judgment of the State and Federal agency personnel responsible for fish and wildlife aspects of the plan, as a minimum all of the elements included are necessary to meet the needs and would, in their estimation, satisfy projected needs. In many instances, even with the planned program, the quality and success of future hunting or fishing would not be as high as it is today. Fish and wildlife use all suitable land and water in the region. Consequently, any conversion to noncompatible uses represents a loss of habitat. In other instances, the conversion of habitat use may generate a different type of fish or wildlife that may or may not be desirable. The plan for fish and wildlife takes into account these shifts, offsets losses, and augments natural production to the extent practicable, consistent with the projected needs. Additional study and evaluation will be required to arrive at a system, other than judgment, that will permit converting needs in terms of human use into meaningful fish and wildlife equivalents.

Sandhill cranes gather in a Malheur Wildlife Refuge meadow (Oregon State Highway Commission).

Table 27—Planned Fish & Wildlife Land & Water Requirements
Columbia-North Pacific Region

Item	Units	1970	1980	2000	2020
Fish hatchery water withdrawals	1,000 ac-ft	2,729	3,373	4,005	5,423
Water withdrawal for wildlife areas 1/	1,000 ac-ft	209	356	505	602
Fish & wildlife water areas 2/	1,000 ac	2,003	2,029	2,055	2,073
Wildlife land use 3/	1,000 ac	165,393	164,324	163,331	162,321
Controlled wildlife land use 4/	1,000 ac	1,423	2,631	3,237	4,088

1/ Includes water developments primarily for waterfowl enhancement.

2/ Includes small critical fishing waters (less than 500 acres each) and high quality waterfowl habitat.

3/ Most land area is used in varying degrees by wildlife. Available lands will slowly be reduced by infringement of urban and industrial areas, development of special use areas, and increased reservoir water areas, despite requirements for enhancement of wildlife resources and increasing hunting demand.

4/ Lands operated or owned and managed by fish and wildlife agencies specifically for wildlife control and enhancement.

The fish and wildlife plan elements, to the extent permitted by an assessment based on judgment, meet the projected needs for pounds of commercial fish and sportsman use. Consequently, the economic efficiency objective for the region would be satisfied. The regional development objective would be satisfied throughout. Most plan elements would be compatible with the environmental quality objectives. This would be especially true of those items involving preservation of habitat, and, in most instances, habitat improvement. However, special care would be required in providing additional sportsman access, introduction of new species, habitat improvements, and management practices to assure that they make beneficial contributions to environmental quality or that any necessary negative effects are minimized. A thorough evaluation would require considerably more basic data and knowledge than are currently available and a careful assessment of unproved innovations.

Water Related Outdoor Recreation

The Columbia-North Pacific Region embodies a wide range of outdoor recreation opportunities. Few regions of the United States have comparable opportunities to enjoy the varied experiences presented by the different geologic, topographic, ecologic, and climatic conditions present here.

The framework plan includes two basic programs to satisfy the additional outdoor recreation needs. One involves preserving and maintaining existing resources so that they would be available in the future; the other is concerned with developing the resources within their capacities to support the increasing use.

The framework plan proposes programs to maintain and enhance the beauty and other esthetic qualities of the environment by waste treatment, water temperature regulation, fish and wildlife preservation, agriculture and forest management, public education, landscape management, streamflow augmentation, stream preservation, and expansion of wilderness and primitive areas. Specific outdoor recreation measures would include: a determination of rivers requiring preservation from a study of more than 10,000 miles of 150 streams; establishing proper level of human use for fragile alpine ecosystems; and consolidating recreation and scenic programs into a Columbia River Parkway. Also to be considered would be a study of almost 7,500 miles of roads for inclusion in the scenic roads system and a detailed examination of some 2.7 million acres of roadless areas for possible designation as primitive or wilderness areas, or otherwise retained in their natural state. The study programs are described later under Additional Studies.

The framework plan includes development of water-related recreation facilities to meet a demand which is projected to rise from over 89 million recreation days in 1970 to more than 511 million recreation days in 2020. A total of about 1.9 million acres of water and nearly 240,000 acres of land (an increase of 209,000 acres over 1970 development) would be needed to accom-

Sunset on Oregon's coastline. This scene is just south of Humbug Mountain along Oregon's 400-mile coastal highway, U. S. 101 (Oregon State Highway Commission).

modate the facilities and use. Nearly one-half of the additional land to be developed would need to be acquired. There is ample water and land available for these purposes except near urban centers where needs surpass land resource capabilities. The required program is set forth by time periods for the region, individual areas, and subregions in tables 17 through 21.

Boating, one of the major recreation activities in the region, would use a large part of the present water surface as well as new water areas provided for in the plan. Pleasure boats are estimated to increase from 423,000 in 1970, to 2,210,000 in 2020. This will require 7,400 more launching lanes plus an additional 29,000+ acres of land for access, parking, etc.

Overall, the framework plan provides for meeting all of the identified water-related recreation needs. However, within the Willamette Subregion, the needs are not fully satisfied with regard to the location of available and planned water surface in relation to the large population of the Portland area. In this instance, a portion of the recreationists from Portland would have to travel to the middle part of the subregion or adjacent subregions to reach ample water and facilities.

As the plan elements for water-related recreation meet the projected needs, the economic efficiency objective would be satisfied. In the Puget Sound and Willamette Subregions, where projections representing regional development objectives were used, the regional development objective would be met.

Most recreation plan elements are consistent with the environmental quality objective, particularly those involving stream and greenbelt preservation, protection of natural and historic areas, and establishment of scenic roads. However, particular attention would have to be given to the construction and operation of recreation facilities to insure an acceptable level of human use and compatibility with environmental considerations.

Related Land Programs

The framework plan includes a wide range of watershed measures and practices designed to reduce erosion and sedimentation, conserve and improve water quality, and alleviate flood damage and wetness problems through a combination of management practices, land treatment, and structural measures. Many different practices are required on some of the same land, some being recurrent in each planning period.

Erosion and sediment control practices would be applied on an additional 18.0 million acres of rangeland, 7.0 million acres of forest land, and 7.0 million acres of cropland between 1970 and 2020. Cropland practices include grade stabilization structures, diversions, ditch bank seeding, crop residue use, and shifts to pasture and hay in areas of higher erosion potential. In

forest areas, trees and grass would be reestablished on eroding or deteriorating lands with particular attention following timber harvest, and existing or abandoned forest roads and trails would be stabilized. Rangeland practices include grass seeding to establish protective cover along with brush and weed control, contouring, and road stabilization. Accompanying these measures, more than 109,800 detention structures and small check dams would be constructed in cropland and rangeland areas.

Onfarm irrigation needs can be partially met through careful water management and increased efficiency of present irrigation systems. Some systems now individually operated should be combined for more efficiency. Other irrigation systems improvements include land leveling and shaping, ditch lining and pipelines to reduce transmission loss, with additional onfarm storage and control facilities. Along with major water storage facilities, an estimated 69,400 ponds and small reservoirs would be developed with a total capacity of some 531,000 acre-feet to serve increased irrigation needs, store water for stock, recreation, and wildlife use, and conserve early spring runoff. The largest number of these structures would be scattered in rangeland areas for livestock and wildlife water.

Along with other management practices on forest land, some 612,000 acres would receive special attention to improve water yield. This includes manipulation of forest cover on 319,000 acres, 2,400 miles of snow fencing, and waterspreading on 133,000 acres. Forest and range lands require continuing protection and management practices to restore and maintain an effective vegetative cover for watershed objectives and for increased production. Grazing use of lands must continually be adjusted to their grazing capacity. Timber sale contracts would include provisions for proper watershed protection practices, and improved harvest operations to assure a minimum temporary damage to the watershed. Continued fire protection and suppression would be effected in forest and range areas. Watershed planning and management are vital elements to be included in all future land and resource development, and additional soil surveys and watershed plans would accompany future development.

Tributary stream control measures and adjacent land protection practices would help attain watershed objectives in erosion and sediment control, flooding, and water conservation. About 17,100 miles of bank stabilization work is proposed between 1970 and 2020 (4,000 miles in cropland, 6,800 miles in forest areas, and 6,300 miles in rangeland) along streams and reservoirs. Some 4,300 miles of dikes and levees would be provided on crop and other land. Channel improvement is planned at intermittent locations along some 28,500 miles of streams and rivers, with about 70 percent in forest areas. This includes a variety of practices such as removal of obstructions and debris, measures for reduction of pollution and improved water quality, and clearing the way for fish migrations.

More intensively used land, such as urban, industrial, roads, highways, and other special use areas, would have substantially improved and esthetic

cover to protect them, especially during construction. While some of this protection would result from measures and practices initiated in these areas, most would occur from improved and more intensive management practices and conditions on surrounding or adjacent crop, range, and forest lands.

These land treatment and management practices have been grouped into several major categories and listed by subregion, area and time periods in tables 17 through 21. Frequently, cooperative effort by a group of land managers and owners is necessary to effectively install a combination of practices, land treatment measures, and water conservation and control structures necessary to meet the more intensive multiple-use requirements of lands and resources. Small watersheds, numbering 896, requiring such coordinated efforts have been tentatively selected for further study to determine their ability to fulfill these needs. They are also shown in the tables. Evaluation studies are required to properly select the ones which are feasible. A substantial amount of the functional needs and the watershed programs and land measures practices included in the plan would be satisfied by development in these watersheds.

The primary objective of the land measures and watershed protection programs is to protect and improve watershed environment in conjunction with intensive, wise, efficient, and multiple use of land and water resources. These programs would allow safe optimum use of the land as productivity is increased to meet food and fiber needs, and as the need for other more intensive uses increases. Thus, if the proposals as advanced in the framework plans were implemented as programmed, the needs of the economic efficiency objective would be satisfied. These accomplishments could be accelerated to help meet the regional development objectives.

Generally, related land programs would also improve, restore, or preserve quality environment while other objectives are being met. A few watershed conditions would require measures having a detrimental effect on the environment. However, emphasis would be placed on improved management techniques or forms of land treatment which would not cause disturbance to the landscape and would improve or restore wildlife habitat, water quality, and esthetic values. Thus, many of the environmental elements of the plan will actually be implemented through the related land programs.

Nature and Extent of Further Studies

The nature and extent of further studies are discussed individually under Formulation of Area Framework Plans and Programs and are listed in tables 17 through 21 by general categories. Each of these study categories is described and discussed in the following text.

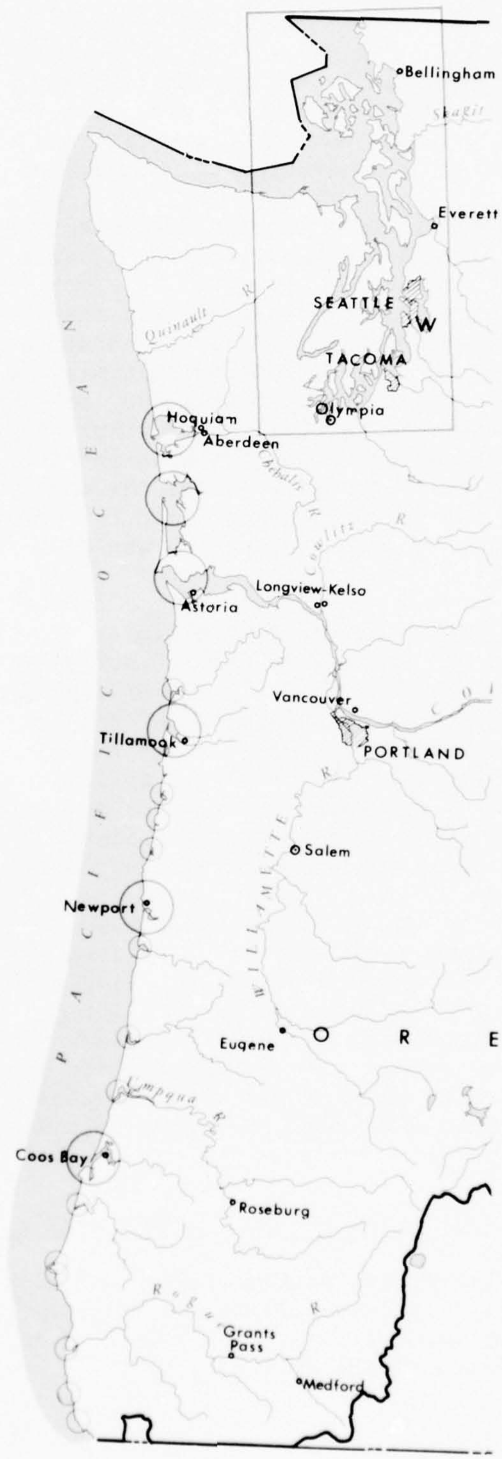


FIGURE 32. Estuarine Areas Needing Additional Studies or Management

Coastal Zone and Estuaries

The entire coastal zone, including Puget Sound and adjacent waters, and the estuary at the mouth of the Columbia River, needs to be carefully examined from the standpoint of beach erosion; preservation of estuarine areas for fish, shellfish, and wildlife; thermal powerplant siting; port facilities; harbors of refuge for small boats; and adjacent land uses such as recreation facilities, agriculture, commercial developments, and preservation of unique and scenic sites.

The framework plan proposes the management of significant estuarine areas, totaling 57,000 acres of water surface in Oregon and 1,733,000 acres of water surface in Washington. Figure 32 shows the location of each of the estuaries. A coordinated plan would be developed for each one to insure that they continue to serve their natural function in maintaining the ecological balance and also provide esthetic, recreational, and economic benefits. Basic to this planning are several needed investigations, including hydrologic and biological studies. The plan would integrate institutions, agencies, managerial techniques, and professional expertise into a program which is flexible enough to meet changing conditions and backed by legislation to permit full implementation.

Specified in the plan is the management and stabilization of tidal beaches by both nonstructural and structural measures. These programs include stabilization of 166 miles of eroding beach in Oregon and 98 miles in Washington, management of all beach areas, and development of the shoreline for public use and enjoyment.

Watersheds

Some 896 watersheds have been identified as requiring measures and practices to reduce erosion and sedimentation, to conserve and improve water quality, or to alleviate flood or wetness problems, and to improve water supply.

State	Watersheds Identified
Idaho	200
Montana	61
Oregon	216
Washington	407
Wyoming	9
Nevada	3
Total	896

Programs to solve these problems include drainage, water conservation and control, erosion control, watershed management, and storage reservoirs. Stream control requires bank stabilization and levees primarily directed toward reducing bank erosion and overbank flooding. A major amount of channel improvements are located on forest land and include removal of debris and logs, installation of riffles and resting pools, and improved runoff conditions, primarily in the interest of fish, wildlife, and water quality improvement. Additional studies are required to select those watersheds that are feasible of development. These studies are scheduled for completion during the first two time periods.

River Basins

In formulating framework plans, major alternatives were developed for each river basin or subarea. While the best alternative could be selected for part of the region, the basins or subareas shown on figure 33 have complex problems and a wide array of alternatives, which, coupled with lack of available data, preclude the selection of the best plans and programs. In those instances, interdisciplinary studies described in the following narrative are recommended:

To further identify alternative methods, programs, projects, and uses of water and related land resources,

To evaluate the impact of alternative land uses and projects, and

To select the proper alternatives and the agency to carry out each feature of the resulting plan.

Studies now underway by State and Federal agencies cover most of the river basins or subareas proposed for future studies. Although many of these ongoing studies have been multiple purpose in design, involving many agencies and disciplines, most have placed primary emphasis on the national efficiency objective with emphasis on the area of agency interest. Accordingly, the scope of these efforts should be expanded to fully consider regional development and environmental objectives, measuring to the extent possible the impacts on both people and natural resources. Table 28 lists major studies underway by Federal and State agencies but does not include small project studies by the Government or water studies by private organizations.

The following describes basins or subareas having major problems requiring further study.

The Flathead River Basin, Montana, has environmental values, the retention of which is a major consideration. Also, there are water quality problems and large potentials for irrigation, power, and flood control. Additional studies are required to evolve a plan

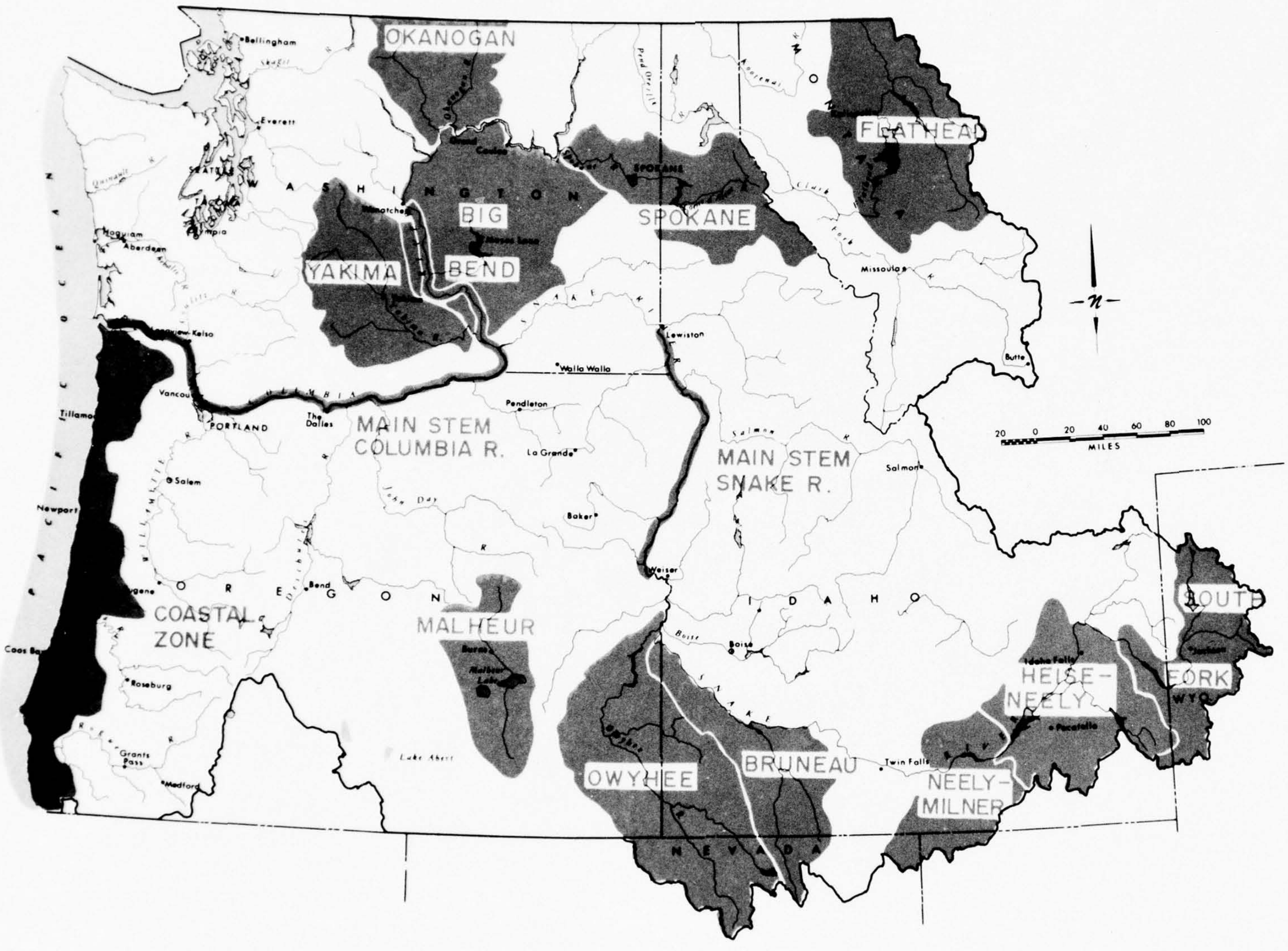


FIGURE 33. Areas Requiring Further Study

Table 28—Major Studies Underway, 1970
Columbia-North Pacific Region

Area	Purpose	Agency[1]	Completion
	Regionwide		
Comprehensive Joint Plan	Multiple-Purpose	PNWRBC	1977
Western US Water Plan	Multiple-Purpose	BR	1977
Columbia River & Tribs	Multiple-Purpose	CE	1977
State Water Plans	Multiple-Purpose	All States	
	Area A - Subregions 1, 2, & 3		
Flathead River-Stillwater Div.	Multiple-Purpose	BR	1974
Spokane River Basin	Multiple-Purpose	BR	1976
Central Washington Area	Multiple-Purpose	BR	1976
Columbia Basin Project	East High & East Low Ext.	BR	1973
Chief Joseph Project-Okanogan Unit	Multiple-Purpose	BR	1971
Chief Joseph Project-Oroville Tonasket Unit	Multiple-Purpose	BR	1972
Yakima Proj.-Ahtanum Unit	Multiple-Purpose	BR	-
Toppenish-Simcoe Proj.	Multiple-Purpose	BIA	-
Wapato-Satus Cr. Proj.	Multiple-Purpose	BIA	-
Mabton Project	Multiple-Purpose	BIA	-
Klickitat Project	Multiple-Purpose	BIA	-
Coeur d'Alene Res.	Soil & Range Inv.	BIA	1973
Yakima Indian Res.	Water Resource Inv.	BIA-GS	1972
Glacier National Park	Water Resource Inv.	GS	1977
Clark Fork-Flathead R.	Water Resource Studies	GS	1973
Lower Flathead Basin	Hydrologic Study	GS	1974
Rathdrum Prairie	Recharge	GS	1971
Blackfoot River Valley	Ground Water Studies	GS	1971
Columbia Basin Area	Ground Water Studies	GS	Continuing
Clark Fork-Flathead R.	Multiple Purpose	CE	1973
Cottonwood Creek	Flood Control	CE	1971
Kootenai R. Near Libby Reregulating Dam	Power	CE	-
Crab Creek Basin	Multiple-Purpose	CE	1974
Spokane River Basin	Multiple-Purpose	CE	1974
Okanogan River Basin	Multiple-Purpose	CE	1977
Yakima River & Tribs.	Multiple-Purpose	CE	1956
Naches River	Flood Plain Info.	CE	-
St. Joe River	Flood Plain Info.	CE	1972
Douglas Creek	Multiple-Purpose	SCS	-
Colville Indian Reservation	Water Resource Inv.	BIA-GS	1975
Lower Moses Coulee	Multiple-Purpose	SCS	-
Goose Creek	Multiple-Purpose	SCS	-
Upper Coulee	Multiple-Purpose	SCS	-
Bockemuehl Watershed	Multiple-Purpose	SCS	-
Mill Creek	Multiple-Purpose	SCS-FS	-
Little Pend Oreille	Multiple-Purpose	SCS-FS	-
Chewelah Creek	Mutliple-Purpose	SCS-FS	-
Calispell-Trimbel	Multiple-Purpose	SCS-FS	-
Cowiche Creek	Multiple-Purpose	SCS-FS	-
Manastash-Taneum	Multiple-Purpose	SCS-FS	-
Wenas Creek	Multiple-Purpose	SCS-FS	-
Wilson Creek	Multiple-Purpose	SCS-FS	-
Whitefish Lake	Multiple-Purpose	SCS-FS	1971
Flathead River	Wild River	FS	1973
St. Joe River	Wild River	FS	1973
Priest River	Wild River	FS	1974
Moyie River	Wild River	FS	1974
Mission Mtn, Primitive Area	Wilderness Class.	FS	1971
Alpine Lakes Area	Wilderness Class.	FS	1973 (Hearings)
Enchantment Area	Wilderness Class.	FS	1973 (Hearings)
Mt. Aix Area	Wilderness Class.	FS	-
Glacier National Park	Wilderness Class.	NPS	-
Spokane River	Flood Plain Reg.	Wash.	1971
Crab Creek	Flood Plain Reg.	Wash.	1971
Little Spokane River	Flood Plain Reg.	Wash.	1971
Colville River	Flood Plain Reg.	Wash.	1971
Pend Oreille River	Flood Plain Reg.	Wash.	1971
Idaho Batholith	Management Plan	FS	1976

Table 28–Continued

Area	Purpose	Agency[1/]	Completion
	Area - B - Subregions 4, 5, & 6		
Grande Ronde River	Multiple-Purpose	BR	1972
Burnt River, Dark Canyon	Multiple-Purpose	BR	1971
Lower Snake River	Multiple-Purpose	BR	-
Minidoka-North Side	Multiple-Purpose	BR	1974
Southwest Idaho			
Bruneau Div.	Multiple-Purpose	BR	1977
Garden Valley	Multiple-Purpose	BR	1973
Weiser River	Multiple-Purpose	BR	1971
Jordan Valley	Multiple-Purpose	BR	1972
Upper Snake River			
Lower Teton	Multiple-Purpose	BR	1972
Lynn Crandall	Multiple-Purpose	BR	1972
Oakley Fan	Multiple-Purpose	BR	1976
Snake River Plain Recharge	Multiple-Purpose	BR	1975
Walla Walla Project			
Milton-Freewater			
Marcus Whitman Div.	Multiple Purpose	BR	1972
Fort Hall Reservation	Water Resource Inv.	BIA	1974
Grand Teton Nat'l Park	Water Resource Inv.	GS	1973
Walla Walla River Basin	Water Resources	GS	1973
Bruneau River	Wild River	BOR	-
Snake River Basin	Multiple Use	BLM	1971-74
West Slope Tetons	Wilderness Class.	NPS	-
Cottonwood Creek	Flood Control	CE	-
Big Wood River	Multiple-Purpose	CE	1974
Palouse River	Multiple-Purpose	CE	1971
Robert-Kettle Butte	Multiple-Purpose	SCS	1972
Sand Creek	Multiple-Purpose	SCS-FS	-
Rock Creek (Power Co.)	Multiple-Purpose	SCS-FS	-
Bancroft	Multiple-Purpose	SCS	1971
Twin Buttes	Multiple-Purpose	SCS	-
Minidoka	Multiple-Purpose	SCS	-
Rock Creek (Twin Falls Co.)	Multiple-Purpose	SCS-FS	-
Salmon River	Wild River	FS	1973
Minam & Eagle Cap Add.	Wilderness Class.	FS	1972
Idaho Primitive Area	Reclassification	FS	1974
Salmon River Breaks Primitive Area	Reclassification	FS	1974
Magruder Corridor	Management Plan	FS	1974-75
White Cloud-Pioneer	Management Plan	FS	-
Payette, Salmon, Boise, Challis, Sawtooth, Teton, Targhee & Bridger N.F.	Water Use Inv.	FS	1974
Palouse River	Flood Plain Reg.	Wash.	1971
Asotin Creek	Flood Plain Reg.	Wash.	1971
Tamarack Valley	Multiple-Purpose	Idaho	1973
Swan Falls-Guffey	Multiple-Purpose	Idaho	-
Boise River	Green Belt	Boise, Id	-
Idaho Batholith	Management Plan	FS	1976
	Area C - Subregions 7, 9, 10S, & 12		
Azalia Div., Umpqua	Multiple-Purpose	BR	1973
Goldendale Div. (Washington)	Multiple-Purpose	BR	1971
White Salmon (Washington)	Multiple-Purpose	BR	1971
White River	Multiple-Purpose	BR	1974
Central Div., Deschutes	Multiple-Purpose	BR	1972
Columbia South Side	Multiple-Purpose	BR	1974
Umatilla Basin	Multiple-Purpose	BR	1973
Tualatin-second phase	Multiple-Purpose	BR	1976
Molalla and Pudding River Basins	Multiple-Purpose	BR	1976
Carlton Div.	Multiple-Purpose	BR	1973
Medford Div.	Multiple-Purpose	BR	1975
Rosealea Div. Umpqua R.	Multiple-Purpose	BR	1973
Evans Valley Div., Rogue River	Multiple-Purpose	BR	1974
Marcus Whitman-Milton Freewater	Multiple-Purpose	BR	1973
Coos Bay Sand Dunes	Hydrology, Water Supply, Water Quality	GS	1972
Mill Creek (Wash.)	Multiple-Purpose	CE	1975

Table 28—Continued

Area	Purpose	Agency[1/]	Completion
Touchet R. (Wash.)	Flood Control	CE	-
Zintel Canyon (Wash.)	Flood Control	CE	1970
Little Klickitat River (Wash.)	Multiple-Purpose	CE	1972
Stage Gulch, Stanfield	Flood Control	CE	-
McKay Creek	Multiple-Purpose	CE	-
Beech Creek-Mt. Vernon	Flood Control	CE	-
John Day River	Multiple-Purpose	CE	1975
Thomas Creek	Multiple-Purpose	CE	1973
Willamette R. Basin	Flood Plain Info.	CE	-
Columbia R. at Bonneville Dam	Navigation	CE	-
Umpqua River	Navigation	CE	-
Nehalem, Miami, Kilchis, Wilson, Trask, & Tillamook Rivers	Multiple-Purpose	CE	1973
Rogue R. at Gold Beach	Navigation	CE	1973
Elk Cr. at Cannon Beach	Flood Control	CE	1972
Umpqua R. & Tributaries	Multiple-Purpose	CE	1972
Nestucca R. & Tributaries	Multiple-Purpose	CE	1971
Coquille R. & Tributaries	Multiple-Purpose	CE	1971
Alsea R. & Tributaries	Multiple-Purpose	CE	1973
Yaquina River	Navigation	CE	1972
Silvies R. & Tributaries	Multiple-Purpose	CE	1972
Dixon Farm Levee Ext.	Flood Control	CE	1971
Marys River	Multiple-Purpose	CE	1976
Luckiamute River	Multiple-Purpose	CE	1976
Oregon Slough	Navigation	CE	-
Bonneville Dam	Power	CE	-
Siletz Bay	Navigation	CE	-
Tillamook Bay (Oreg.)	Navigation	CE	-
Siuslaw River	Navigation	CE	-
Chetco River	Navigation	CE	-
Necanicum Creek	Flood Plain Info. Study	SCS	1972
John Day Fossil Beds		NPS	
River Road Section-Willamette River	Flood Plain Info. Study	SCS	1972
Sandy River	Flood Plain Info. Study	SCS	1972
Grand Prairie	Flood Plain Info. Study	SCS	1972
Calapooya River	Flood Plain Info. Study	SCS	1972
Lower Rogue River	Flood Insurance Study	SCS	1971
Lane County	Generalized Flood Plain Study	SCS	1972
Hood River County	Generalized Flood Plain Study	SCS	1972
Polk County	Generalized Flood Plain Study	SCS	1972
Lincoln County	Generalized Flood Plain Study	SCS	1972
Umatilla R. & Willow Cr.	Watershed Management	SCS	-
Vannoy Watershed	Multiple-Purpose	SCS-FS	-
Necanicum Creek	Multiple-Purpose	SCS-FS	-
Little Luckiamute River	Multiple-Purpose	SCS-FS	-
Grand Prairie	Multiple-Purpose	SCS-FS	-
McKay-Rock Creeks	Multiple-Purpose	SCS	-
Hudson Bay Watershed	Multiple-Purpose	SCS-FS	-
Deer Creek	Multiple-Purpose	SCS-FS	-
Oak Grove	Multiple-Purpose	SCS-FS	-
Rock Creek	Multiple-Purpose	SCS-FS	-
Upper Nehalem River	Multiple-Purpose	SCS-FS	-
Calapooya Creek	Multiple-Purpose	SCS-FS	-
Little Butte Creek	Multiple-Purpose	OSE-SCS-FS	-
Ash Creek	Multiple-Purpose	OSE-SCS-FS	-
Rhea Creek	Multiple-Purpose	OSE-SCS-FS	-
Lonerock-Sixmile Creeks	Multiple-Purpose	OSE-SCS-FS	-
Fifteenmile Creek	Multiple-Purpose	OSE-SCS-FS	-
Trout Creek	Multiple-Purpose	OSE-SCS-FW	-
Willamette River Basin	Warm Water Irrigation	EWEB	-
Oregon Rivers (Type IV)	Multiple-Purpose	OWRB-USDA	Continuing (1975)
Crater Lake Nat'l Park	Wilderness Class.	NPS	-
Mt. Hood Wilderness Add.	Wilderness Class.	FS	-
Sky Lakes	Wilderness Class.	FS	-
Illinois River	Wild River	FS	1975

Table 28—Continued

Area	Purpose	Agency[1/]	Completion
	Area D- Subregions 8, 10N, & 11		
Port Susan Bay	Fish & Wildlife	BSF&W	1971
Nisqually Bay	Fish & Wildlife	BSF&W	1971
Duwamish R. Estuary	Water Quality	GS	Continuing
Skookumchuck River	Multiple-Purpose	GS	Continuing
Seattle Hbr-Duwamish Waterway	Navigation	CE	1972
Puyallup River Basin	Flood Control	CE	-
Chehalis River Basin	Flood Control & Flood Plain Management	CE	1973
Nooksack River	Multiple-Purpose	CE	1972
Snohomish River	Multiple-Purpose	CE	1976
Grays Harbor	Navigation	CE	1973
Elliott Bay	Navigation	CE	1971
Cape Shoalwater to Willapa Harbor	Navigation, Beach Erosion	CE	-
Lower Columbia River	Multiple-Purpose	CE	1972
Vancouver Lake	Multiple-Purpose	CE	-
Chinook-Wallicut	Multiple-Purpose	FS-SCS	-
Skagit River	Wild River	FS	1974
Mt. Baker Nat'l Forest	Water Use Inv.	FS	1972
Snoqualmie Nat'l Forest	Water Use Inv.	FS	1972
Olympic Nat'l Forest	Water Use Inv.	FS	1972
SW Washington (Type IV)	Multiple-Purpose	Wash—USDA	1973
Cedar & Green R. Basins	Water Quality	EPA-State-CE-Local Gov't	1974
Upper Baker River	Flood Control	CE	1974
Stillaguamish River	Flood Control	CE	1974
Cedar River	Multiple-Purpose	CE	1974
Tacoma Harbor	Navigation	CE	1974

1/ Abbreviations used:

PNWRBC	— Pacific Northwest River Basins Commission	BOR	— Bureau of Outdoor Recreation
BR	— Bureau of Reclamation	BLM	— Bureau of Land Management
CE	— Army Corps of Engineers	OSE	— Oregon State Engineers
BIA	— Bureau of Indian Affairs	EWEB	— Eugene Water and Electric Board
GS	— Geological Survey	OWRB	— Oregon Water Resource Board
SCS	— Soil Conservation Service	USDA	— U.S. Department of Agriculture
FS	— Forest Service	BSF&W	— Bureau of Sport Fisheries & Wildlife
NPS	— National Park Service	EPA	— Environmental Protection Agency

which retains the high environmental values and still provides an acceptable level of development.

Spokane River Basin, Idaho and Washington, is faced with serious water supply and quality problems. Augmentation of streamflows is needed for water quality and for fishery as well as for irrigation. There are a number of alternative plans, one of which includes upstream storage in Idaho.

The main stem of the Columbia River to the Canadian border contains a continuous series of dams and reservoirs, except for the reaches of open river below Priest Rapids and Bonneville Dams. As electric power generation shifts to a thermal base, the installation at some existing projects would be expanded and the system operated more and more for peaking, resulting in larger fluctuations in some open river reaches. Alternatives range from nondevelopment to full structural installation including the extension of barge navigation to Wenatchee. Studies are required to select the best plan, recognizing the possible conflicts between development and the preservation of environmental values. These studies should establish the effect of peaking operations, develop an overall plan for future use of the river and its related lands, and arrive at a plan for consolidation of all recreation and scenic activities into a parkway with associated facilities along selected reaches of the entire river.

The Big Bend Subarea in Washington needs water for irrigation, low-flow augmentation, water quality, fish and wildlife, and esthetics. Control of high flows to avoid flood damages is also required. A combination of physical measures should be studied to develop a plan which insures compatibility between the water and related land functions.

The Okanogan River Basin, Washington, is short of water for both irrigation and low flow augmentation for water quality control. Flood control is also needed. Alternatives range from a plan based on upstream storage in Canada to one consisting of modernizing and improving existing irrigation systems. Availability of Canadian storage is the key to development of a comprehensive plan.

Yakima River Basin's future and present prosperity is closely related to the quantity and quality of its water supply. Water quality of the river is adversely affected by waste effluents and agricultural return flows. The basin is also subject to recurring flood damages. The fishery in the river has declined, primarily due to low flows, poor fish passage facilities, and overfishing. The Yakima Indian Reservation needs water supplies. Studies are needed to select a plan which provides adequate supplies for irrigation, improves the river water quality, and improves the fishery. These studies need to consider adjusting operations of existing reservoirs, interbasin water transfers, and the satisfaction of the rights of the Yakima Indian Reservation.

The South Fork Snake River in Wyoming and Idaho has major environmental values which must be retained. Also, there are large potentials and needs for the development of storage to serve almost

all functions and purposes. Particularly important are replacement of Jackson Lake storage to permit its stabilization for recreation use and additional storage to satisfy instream and diversion needs. Preliminary studies have identified a number of possible storage sites, each of which would have certain adverse effects upon the environment. The location and sizing of this storage will require further study particularly with respect to the degree of use of the Snake Plain Aquifer.

The Snake Plain Aquifer must be relied on to supply large volumes of water for diversionary and instream needs throughout the Upper and Middle Snake Subregions. However, much remains unknown about the aquifer that will require detailed studies. Questions to be answered pertain not only to supply, but also to well field and artificial recharge locations, rate of water movement in the aquifer, effects of pumping and recharge on outflow at Thousand Springs, effects on existing wells, water quality aspects, and related problems.

Studies also are required for replacement water for Market and Grays Lakes. These lakes have significant potential as wildlife refuges and recreational activity of various kinds if means can be provided to maintain the water at optimum levels. Enlargement of Blackfoot Reservoir is one possibility that should be studied along with ground-water development in the Blackfoot River Valley.

Several reaches of the Snake River have serious surface water quality problems that could be aggravated by future development if not corrected, resulting in even more serious impacts upon people and the economy. Associated with water quality are the needs for adequate flows for fish, recreation, and the general esthetic quality of the Snake River which flows through or near the more populated areas of Idaho. Studies are needed of the maintenance of water quality flows by some adjustment in the operation of reservoirs, and joint-use ground-water pumping for dry years. Studies are also needed to determine whether ground-water pumping or upstream storage is the best source for water quality flow augmentation and for consumptive uses.

The Snake Basin has vast land resources which require careful consideration, including several million acres of potentially irrigable land. The major problems are inadequate water supply and appropriate method of getting water to the land. If adequate supplies can be developed from the Snake Plain Aquifer or other sources, problems still remain with respect to the method of delivering water to the land. There are also over a million acres of water-short irrigated lands needing supplemental supplies. Many of the water-short lands are in areas where additional streamflows or ground water are not available.

The Snake River between Weiser and Lewiston may require very intensive study before optimum solutions to problems can be determined. Water quality aspects, such as dissolved oxygen levels, temperature, and nitrification, are of prime importance because of anadromous fish which use the lower part of Snake River to reach the Salmon, Clearwater, and other streams. There is also considerable hydroelectric power potential that could be developed. However, economic and political issues must be resolved first.

Malheur Lakes Basin needs a study of the propriety of future water resource development in the basin, particularly the Silvies River Subbasin, with particular reference to the effect on the Malheur National Wildlife Refuge. The framework plan is based on the tentative premises that (1) development of ground water is preferable to surface water, and (2) the ground-water resource generally is adequate to meet the area's projected developmental needs. Therefore, the framework study's plan recommends early identification of the extent and availability of ground water and the effects of surface and ground-water withdrawals on the operation of the lake.

Coastal drainage basins of Oregon and Washington have a critical need for comprehensive planning and management to retain environmental values. The primary areas of concern are the estuaries which have high biological productivity and unique scenic, recreational, and esthetic values. Accordingly, the zone's water and related lands represent aspects of principal concern for which planning must be carried out on an accelerated schedule.

Special Studies

Special studies required to obtain facts for planning would be made by the agency having the paramount interest, responsibility, or expertise. Some of these investigations would obtain data for river basin studies. Others would be sources of information for state, local, or individual agency programs.

Minimum and Optimum Flows The natural environmental values of a stream depend both on the character of the shoreline and its flow characteristics. When the streamflows decrease below reasonable levels, streams can be unattractive and lose much of their esthetic values. In addition to the esthetic aspects, minimum streamflows are required for fish, recreation, and water quality. Studies of all streams, considering the above, are required to establish withdrawal limits and determine low-flow augementation requirements. In some areas, planning cannot proceed until minimum instream flows have been agreed upon. The initial emphasis of the instream study would focus on sites where use or control of water is likely to change and/or where there is a need to improve streamflow conditions for aquatic life.

Preservation of Streams The Columbia-North Pacific Region contains 342 miles of rivers designated as components of the national wild and scenic rivers system. An additional 2,239 miles of rivers have been selected for study under sections 5a and 5d of P.L. 90-542 to determine if they should be included in the system.

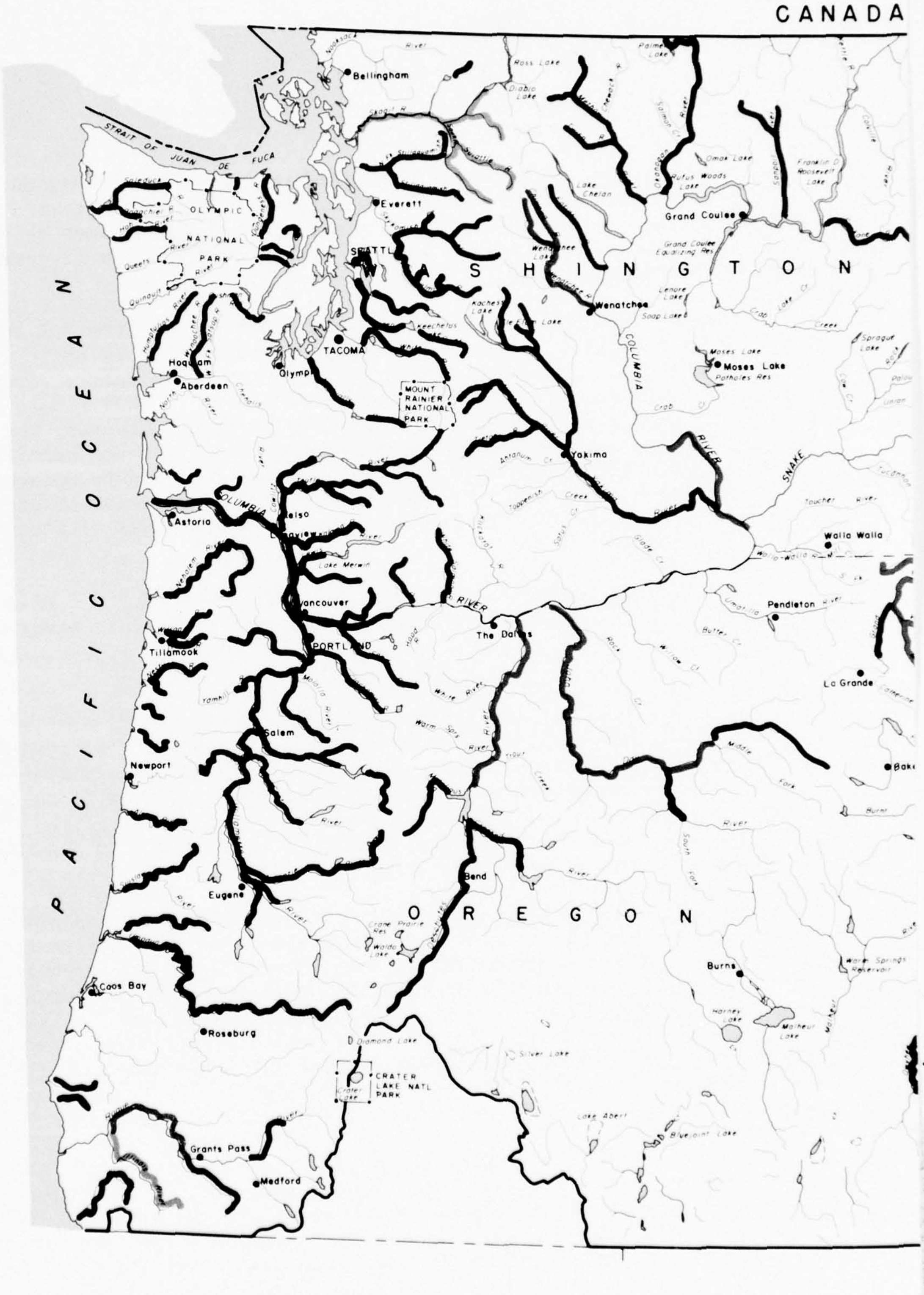
During the framework study, over 8,300 miles on over 200 streams were found to have significant recreation value, in addition to those already set aside by the Wild and Scenic Rivers Act. The plan includes a study of those stream segments during 1970-80 period to determine if they should become part of a state or national system of recreation streams. However, the Idaho Water Resources Board has requested that streams in Idaho not now being studied under the Wild and Scenic Rivers Act be further screened to determine which ones have the highest potential for inclusion in a national or state system because the detailed studies required for all 2,000 miles of stream could not be accomplished by 1980.

The streams selected or designated for study under the Wild and Scenic Rivers Act and those identified as having potential by this study are shown on figure 34.

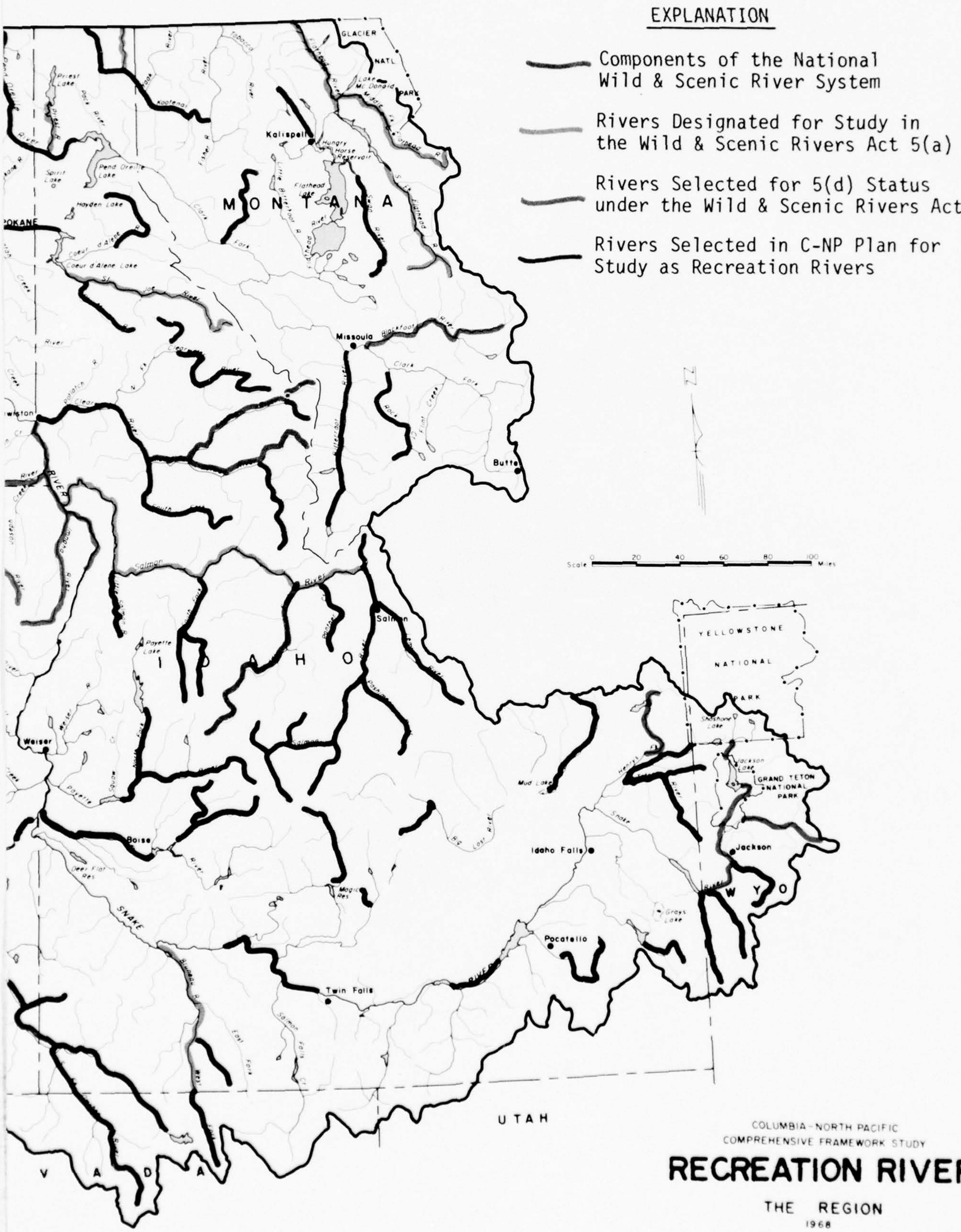
Scenic Roads In addition to existing scenic roads, nearly 7,500 miles of roads mostly along streams have been identified for study as shown on figure 35. Landscape management and control measures adjacent to these roads should be undertaken. The objective of this program is to provide a natural background setting to add to the enjoyment of travelers. The framework plan calls for study to develop a regional scenic road plan with proposals for retaining and improving scenic opportunities.

Primitive or Wilderness Areas Numerous wilderness and primitive features exist within the area and acreages adjacent to some of these features have been set aside for leisure, recreation, and scientific study. Although data are presently not available to accurately determine future needs, nearly 2.7 million acres of roadless area have been identified as potential additions to a State or Federal wilderness system or other classification which would retain the lands in their natural state. The plan includes the provision to complete these studies during the early action period. The general location of these potentials is indicated in figure 36.

Scenic, Historic, and Unique Areas The region has many historic, geologic, archeological, natural, and other unique sites. There are numerous designated historic sites such as sites along the Oregon Trail, the Lewis and Clark Trail, old mining camps, ghost towns, Indian camps, and battlefields. Only limited archeological excavations have been carried out. Some of the sites are Wellman Butte Cove, Simon Cove Site, Mecham Burial Cave, Sampson Site, Wellman Creek Rockshelter, Owl Caves, Ice Harbor and adjacent lower Snake sites, Marmes Rockshelter, and Granite Point. Geologic, natural, and


CANADA
PACIFIC OCEAN
WASHINGTON
OREGON
STRAIT OF JUAN DE FUCA
OLYMPIC NATIONAL PARK
MOUNT RAINIER NATIONAL PARK
CRATER LAKE NATL PARK
Bellingham
Everett
SEATTLE
TACOMA
Olympia
Hoquiam
Aberdeen
Astoria
Kelso
Longview
Vancouver
PORTLAND
Tillamook
Salem
Newport
Eugene
Coos Bay
Roseburg
Grants Pass
Medford
Bend
The Dalles
Yakima
Wenatchee
Grand Coulee
Moses Lake
Walla Walla
Pendleton
La Grande
Burns
COLUMBIA
RIVER
SNAKE
Lake Chelan
Ross Lake
Diablo Lake
Omak Lake
Rufus Woods Lake
Franklin D. Roosevelt Lake
Grand Coulee Equalizing Res
Potholes Res
Soap Lake
Lake Merwin
Diamond Lake
Crescent Lake
Silver Lake
Lake Abert
Malheur Lake
Harney Lake
Warm Springs Reservoir

N



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

RECREATION RIVERS

THE REGION

1968

FIGURE 34

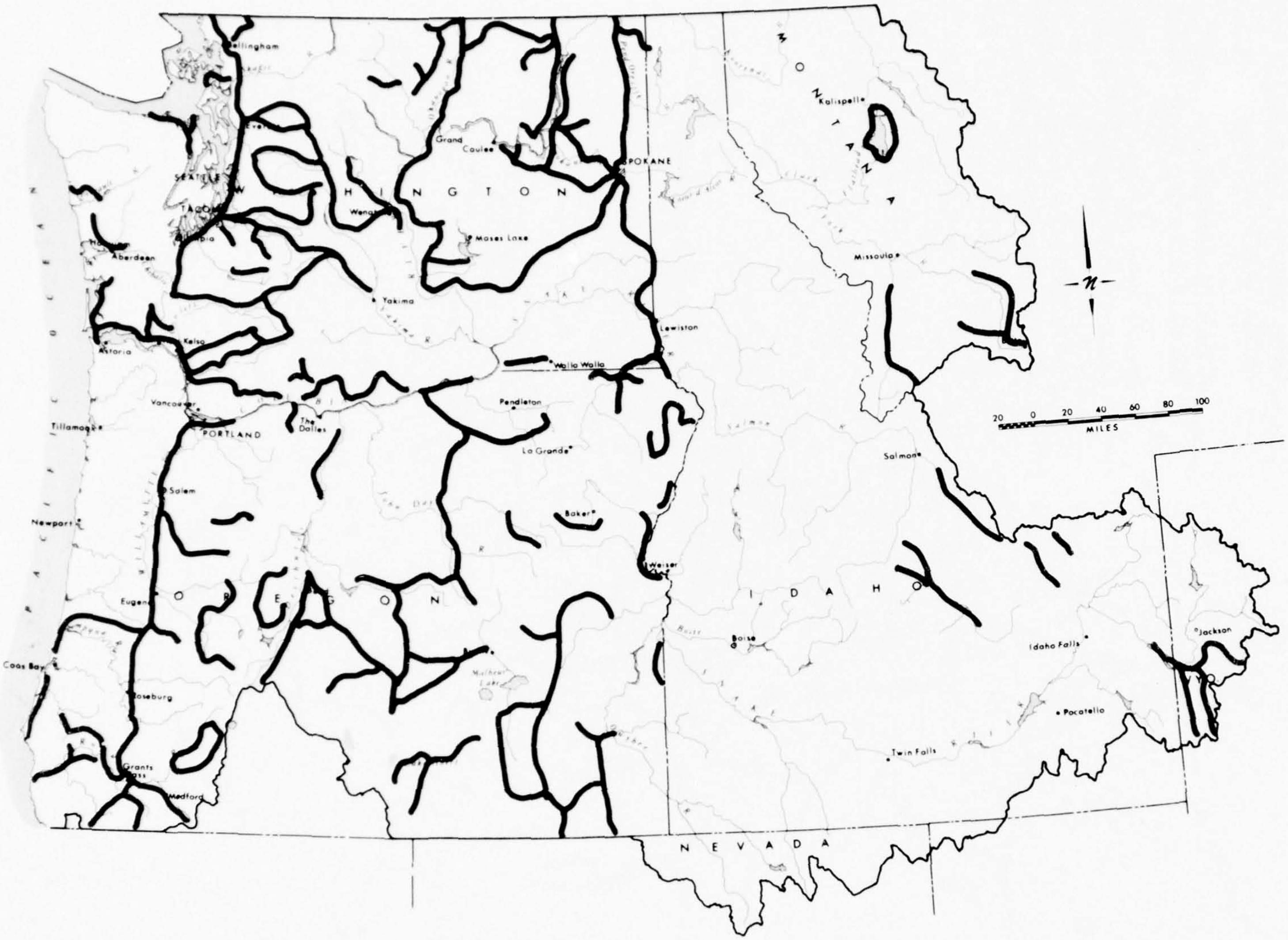


FIGURE 35. Potential Scenic Roads

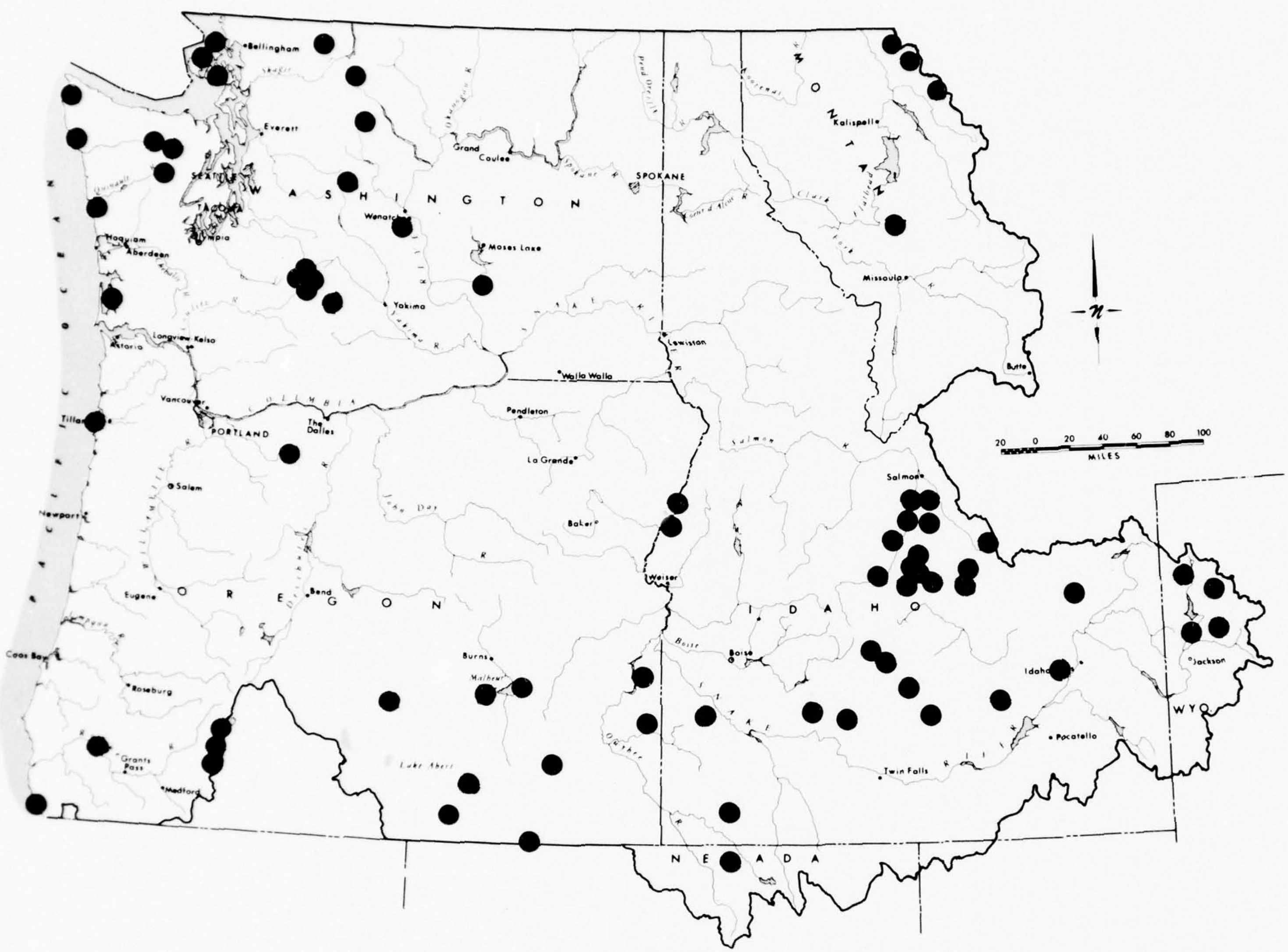


FIGURE 36. Potential Roadless Areas Designated for Study

unique areas that are known and deserving of recognition are: Realm of the Buttes, Big Desert and Arco Desert, Lost River and Birch Creek Sinks, St. Anthony Sand Dunes, Bruneau Jarbidge Canyon, Bruneau Sand Dunes, Thousand Springs, Swan Falls Canyon, Jordan Craters, Game Creek, Salmon Falls Canyon, China Cup Butte, Crater Rings, Big Southern Butte, Whitehorse Desert, Pine Creek, Turnbull Pine, Grand Coulee Dam, and Dry Falls. These and other significant natural, archeological, and historical areas should be identified, classified, protected, and interpreted through both Federal and State systems. A plan would then be developed for their preservation and management.

Columbia River Shorelands A detailed study of the Columbia River shorelands would be made to develop a coordinated water and related land use plan and to chart the future use of the river for industrial, residential, commercial, and recreational uses and for preservation of the natural environment. This planning could lead to the ultimate development of a scenic parkway along most of the United States' portion of the river and, with the cooperation of Canada, to the headwaters of the Columbia River system. The Columbia River should be viewed from its geological standpoint, its historic and ecological aspects, its scenic and fish and wildlife assets, as well as water and related land activities and a plan developed for implementation jointly by private, State, and Federal efforts.

Removal of Piling Many rivers have abandoned piling which obstructs the recreational use of the river and impairs the scenic values. Studies would be made which would lead to removal of piling, except those used by wildlife, as soon as they have served their purpose.

Coastal and High Alpine Areas The coastal and high alpine areas have fragile ecological balances; and, while the apparent need is to increase the recreational capacity through a strong development program, care must be taken lest the resources themselves be destroyed by overuse. A study is needed to find answers to the question of the proper level of human use prior to initiation of development programs. The study should be completed as early as possible to prevent any irreversible damage by the ever-increasing number of recreationists.

Flood Plain Information Studies These studies are the key to managing flood plains by providing information on high flows and the nature and extent of the flood plain. Flood plain regulation would minimize future increases in flood damages by insuring that future development of flood plain lands is consistent with the level of flood protection provided.

Powerplant Siting Studies would be made to provide guidelines for

siting thermal and hydroelectric powerplants which would consider all aspects of economics, environment, air and water pollution, and safety. Suitable sites then could be identified and evaluated and a regional plan formulated.

Habitat Improvement for Fish and Wildlife Habitat improvement opportunities and a wide variety of measures to help expand the habitat base would be studied. Fishery measures to be considered would include: (1) the removal of stream barriers or the installation of passage facilities to increase the spawning area for anadromous fish, (2) the determination of corrective measures to eliminate the hazard of nitrogen supersaturation on the Columbia River system, (3) the improvement of water quality, (4) the increase or regulation of streamflows to restore, improve, or maintain habitat, (5) the installation of gradient reducing devices. Other means that should be examined would include chemical control of undesirable fish, development of spawning beds in streams, fertilization of some lakes, introduction of beneficial aquatic plants and food organisms, construction of fish shelters, removal of debris, and control of aquatic weeds.

Some wildlife habitat improvements to be investigated would be manipulation of ecosystems, timber management for big game, brouse farming, zoning for big game, control of livestock grazing, fencing, expanding natural cover, increasing food supply, preservation of prime habitat areas, incorporation of fish and wildlife habitat preservation in developments, and many others.

Fish and Wildlife Research Fish and wildlife biology is a broad field involving complex interrelationships between organisms and their environment. Many facets of these interrelationships are not known, or are imperfectly understood. A large amount of research is urgently needed as a basis for scientific management of these resources and to assist in coordinated resource planning of the total environment. If future demands on the resources are to be met, a coordinated, well funded research program involving the states as well as the Federal Government, should be instituted and the results applied to the conservation and enhancement of fish and wildlife. Appendix XIV, Fish and Wildlife, lists 59 items of the most urgent research.

Waste Water Sewage collection in each basin would be investigated and regional plans prepared leading to water quality control and pollution abatement in conformance with established Federal-State guidelines.

Lake Water Quality Major water quality problems caused by excess nutrients are developing at some lakes and reservoirs. The source and amount of these nutrients must be determined and studies completed to determine if they can be controlled or eliminated. This may require, in some cases, land use plans for shoreline areas.

Urban Environmental Protection and Development Methods for preserving and enhancing quality aspects of the Willamette River Valley and the Puget Sound area would be studied. The emphasis would be on methods to provide for livability in harmony with expansion of the economy and population.

Urban Waterfronts The land area peripheral to surface waters in urban areas has been intensely developed, particularly in port areas such as Tacoma and Seattle, and used without benefit of any formal planning. This often has resulted in development of the land resource and the adjacent water resource in such a manner that the areas involved are neither economically viable, environmentally desirable, or esthetically acceptable. Studies would be made to identify the severity of this problem and to develop plans which would guide the redevelopment and refurbishing of the affected areas and future development of these areas. The goal would be the creation of urban waterfronts that are economically viable, environmentally acceptable, and esthetically desirable.

Regional Harbor Study A regional port study would be made to evaluate the effect changes in shipping technology will have on commodity movements and to determine future port requirements as well as the means to accommodate these requirements.

Land Use Planning One of the measures which should not be overlooked in initial framework planning for the use of the water and related land is a land-use plan. Although such a plan is beyond the scope and authority of this study, it is recommended as an additional study because the future competition for land will be particularly keen in this area.

Special Snake River Basin Studies The scarcity of water and competition for its use requires that plans, objectives, and alternatives for Snake River Basin be closely related to the management of flows in the Snake River. The river provides the major source of surface water and is, therefore, the key to resolving conflicts and assuring the best use of available resources to meet needs.

In order to display system effects of present and future water uses, hydrologic and water quality computer models would be prepared for the Snake River and its important tributaries, structured to permit maximum flexibility in studying alternatives. Major work elements would include data on river flows, reservoir contents, diversions, return flow data, and operation of present facilities. Output of the models would include predicted flows under future development, reservoir contents, water quality data, and information necessary to evaluate system effects.

Other studies would determine (1) the beneficial use requirements for irrigation; (2) what happens to diversions not used by plants and their effect on the Snake Plain Aquifer return flows; (3) the feasibility of extensive canal lining, sprinkler irrigation, and other water-saving programs on the aquifer and flows downstream; (4) present storage capability to regulate flows for beneficial use with the implementation of extensive water-savings programs; (5) adverse effects, if any, of lined canals on wildlife habitat, flood control, irrigation operation and maintenance programs, farm layout, roads, or other works; (6) the legal and political problems that would be encountered with a water-saving program and how to resolve them. As a special environmental item, the extensions of planned greenbelts from Lucky Peak Dam to mouth of Boise River and along the Payette River would be investigated.

COSTS

General cost estimates in 1970 dollars for broad components of the regional framework plans and programs are shown on table 29. These estimates are approximations based on experience and are included for the purpose of illustrating the general magnitude of Federal and non-Federal costs for installation and for annual operations, maintenance, and replacement. The operation, maintenance, and replacement costs are as of the last year of each time encrement.

The programs included in the early time period would require a total Federal investment of $6.34 billion and a non-Federal investment of $5.92 billion. The land treatment programs, including erosion and sediment control, water conservation and yield improvement, would comprise 35 percent of the total program costs. The next largest feature of the program would be irrigation and associated multiple-purpose storage with 31 percent. Costs for water supply and waste treatment would be 14 percent of the total investment. While the costs for hydroelectric power, without transmission, would be 8 percent. Other programs, such as navigation, flood control, fish and wildlife, and recreation, would comprise the balance of the program. Total annual operation, maintenance, and replacement costs are estimated to be $42.3 million Federal and $187 million non-Federal.

In the long-range time periods annual investments would decrease about 50 percent with related land programs continuing to be the largest single feature. Irrigation and associated multiple-purpose storage would be less but programs serving people, recreation and water supply and quality control, would be sharply increased. Associated costs for thermal-electric power and power peaking resources would amount to $44 billion during the final time frame, and annual power operation, maintenance, and replacement costs would be $1.55 billion per year by 2020.

Similar costs for each of the four areas are contained in tables 30 through 33.

Table 29—Summary of Costs, Framework Plan
Columbia-North Pacific Region

Major Element	1970-1980 Investment	1970-1980 OM&R (Incr) 1/	1981-2000 Investment	1981-2000 OM&R (Incr) 1/	2001-2020 Investment	2001-2020 OM&R (Incr) 1/	1970-2020 Investment	1970-2020 OM&R 2/
				(in $1,000 units)				
Water Development & Control								
1. Electric Power	994,000	6,038	188,500	2,619	1,011,500	6,085	2,194,000	14,742
2. Navigation	184,380	14,603	579,551	32,516	213,212	21,253	977,143	68,372
3. Water Quality Control	960,317	41,221	1,255,281	29,816	1,426,970	14,183	3,642,568	85,220
4. M & I Water Supply	752,700	5,400	856,000	10,200	1,003,400	10,300	2,612,100	25,900
5. Flood Control	227,271	7,061	156,465	4,379	77,017	2,544	460,753	13,984
6. Irrigation	2,674,660	30,780	1,764,761	14,333	2,377,797	25,719	6,817,218	70,832
7. Reservoir Storage	1,196,360	5,374	1,008,670	5,077	310,033	1,178	2,515,063	11,629
Subtotal	6,989,688	110,477	6,632,228	102,406	5,596,929	77,796	19,218,845	290,679
Water and Related Land Programs								
8. Fish & Wildlife	392,719	39,275	335,439	33,544	365,752	36,573	1,093,910	109,392
9. Recreation (Water Related)	549,737	15,838	832,715	31,211	1,444,210	54,702	2,826,662	101,751
10. Related Land Programs	4,326,428	63,813	5,306,655	66,419	4,644,037	66,303	14,277,120	196,535
11. Further Studies				(not estimated)				
Subtotal	5,268,884	118,926	6,474,809	131,174	6,453,999	157,578	18,197,692	407,678
Total	12,258,572	229,403	13,107,037	233,580	12,050,928	235,374	37,416,537	698,357
Federal	6,339,682	42,338	6,117,665	51,129	5,251,989	45,257	17,709,336	138,724
Non-Federal	5,918,890	187,065	6,989,372	182,451	6,798,939	190,117	19,707,201	559,633
Associated Costs								
12. Thermal Electric Power	731,000	51,000	8,638,000	589,000	36,470,000	1,479,000	45,839,000	2,119,500
13. Power Peaking	-	-	1,725,000	16,000	7,590,000	70,600	9,315,000	86,600
Total Associated Costs	731,000	51,000	10,363,000	605,000	44,060,000	1,550,100	55,154,000	2,206,100

1/ Relates only to new investment during period.
2/ Relates to total investment, 1970-2020.

Table 30—Summary of Costs, Framework Plan, Area A

Major Element	1970-1980 Investment	1970-1980 OM&R (Incr) 1/	1981-2000 Investment	1981-2000 OM&R (Incr) 1/	2001-2020 Investment	2001-2020 OM&R (Incr) 1/	1970-2020 Investment	1970-2020 OM&R 2/
				(in $1,000 units)				
Water Development & Control								
1. Electric Power	420,000	1,970	705,500	3,286	50,000	475	1,175,500	5,731
2. Navigation	-	-	109,300	1,147	1,520	104	110,820	1,251
3. Water Quality Control	157,606	4,847	261,384	5,867	289,071	2,698	708,061	13,412
4. M & I Water Supply	112,800	700	126,400	1,300	141,900	1,400	381,100	3,400
5. Flood Control	40,075	281	15,355	76	5,145	29	60,575	386
6. Irrigation	1,034,090	8,053	622,688	3,973	1,347,625	11,118	3,004,403	23,144
7. Reservoir Storage	105,500	440	126,743	128	132,933	196	365,176	764
Subtotal	1,870,071	16,291	1,967,370	15,777	1,968,194	16,020	5,805,635	48,088
Water and Related Land Programs								
8. Fish & Wildlife	78,144	7,817	45,652	4,565	64,222	6,420	188,018	18,802
9. Recreation (Water Related)	31,958	1,925	85,905	5,175	153,550	9,250	271,413	16,350
10. Related Land Programs	1,497,874	12,957	1,530,605	16,662	1,299,159	18,697	4,327,638	48,316
11. Further Studies				(not estimated)				
Subtotal	1,607,976	22,699	1,662,162	26,402	1,516,931	34,367	4,787,069	83,468
Total	3,478,047	38,990	3,629,532	42,179	3,485,125	50,387	10,592,704	131,556
Federal	1,963,445	10,904	2,036,315	10,931	1,997,771	15,149	5,997,531	36,984
Non-Federal	1,514,602	28,086	1,593,217	31,248	1,487,354	35,238	4,595,173	94,572
Associated Costs								
12. Thermal Electric Power	264,000	18,000	440,000	30,000	15,400,000	85,000	16,104,000	133,000
Total Associated Costs	264,000	18,000	440,000	30,000	15,400,000	85,000	16,104,000	133,000

1/ Relates only to new investment during period.
2/ Relates to total investment, 1970-2020.

Table 31—Summary of Costs, Framework Plan, Area B

Major Element	1970-1980 Investment	1970-1980 OM&R (Incr)1/	1981-2000 Investment	1981-2000 OM&R (Incr)1/	2001-2020 Investment	2001-2020 OM&R (Incr)1/	1970-2020 Investment	1970-2020 OM&R 2/
				(in $1,000 units)				
Water Development & Control								
1. Electric Power	224,000	1,898	159,000	1,319	131,000	2,031	514,000	5,248
2. Navigation	6,680	668	29,351	539	3,092	309	39,123	1,516
3. Water Quality Control	137,513	5,176	201,907	4,565	255,255	2,257	564,675	11,998
4. M & I Water Supply	69,800	500	78,500	900	89,000	900	237,300	2,300
5. Flood Control	21,896	260	7,410	35	4,167	21	33,473	316
6. Irrigation	993,357	14,577	691,121	5,334	538,361	9,150	2,222,839	29,061
7. Reservoir Storage	239,266	1,887	192,272	1,057	-	-	431,538	2,944
Subtotal	1,692,512	24,966	1,359,561	13,749	990,875	14,668	4,042,948	53,383
Water and Related Land Programs								
8. Fish & Wildlife	54,880	5,488	66,927	6,693	50,767	5,077	172,574	17,258
9. Recreation (Water Related)	34,030	2,050	85,490	5,150	148,155	8,925	267,675	16,125
10. Related Land Programs	739,787	27,475	1,045,153	20,359	826,154	24,811	2,611,094	72,645
11. Further Studies				(not estimated)				
Subtotal	828,697	35,013	1,197,570	32,202	1,025,076	38,813	3,051,343	106,028
Total	2,521,209	59,979	2,557,131	45,951	2,015,951	53,481	7,094,291	159,411
Federal	1,528,148	9,311	1,206,257	9,051	1,158,955	10,527	3,893,360	28,889
Non-Federal	993,061	50,668	1,350,874	36,900	856,996	42,954	3,200,931	130,522
Associated Costs				(none)				

1/ Relates only to new investment during period.
2/ Relates to total investment, 1970-2020.

Table 32—Summary of Costs, Framework Plan, Area C

Major Element	1970-1980 Investment	1970-1980 OM&R (Incr)1/	1981-2000 Investment	1981-2000 OM&R (Incr)1/	2001-2020 Investment	2001-2020 OM&R (Incr)1/	1970-2020 Investment	1970-2020 OM&R 2/
				(in $1,000 units)				
Water Development & Control								
1. Electric Power	280,000	1,270	130,000	1,330	7,500	113	417,500	2,713
2. Navigation	29,200	1,235	76,900	2,030	6,400	640	112,500	3,905
3. Water Quality Control	298,098	16,879	517,294	17,966	591,049	5,504	1,406,441	40,349
4. M & I Water Supply	243,800	1,400	250,000	2,300	280,400	2,300	774,200	6,000
5. Flood Control	44,900	395	53,500	268	18,800	94	117,200	757
6. Irrigation	538,088	5,466	416,290	4,397	408,091	4,479	1,362,469	14,342
7. Reservoir Storage	656,535	2,897	472,955	3,732	163,100	972	1,292,590	7,601
Subtotal	2,090,621	29,542	1,916,929	32,023	1,475,340	14,102	5,482,900	75,667
Water and Related Land Programs								
8. Fish & Wildlife	137,209	13,721	141,739	14,739	126,950	12,695	405,898	40,590
9. Recreation (Water Related)	57,934	3,490	153,550	9,250	292,575	17,625	504,059	30,365
10. Related Land Programs	1,355,054	19,113	1,640,870	25,636	1,496,515	18,936	4,492,439	63,685
11. Further Studies				(Not estimated)				
Subtotal	1,550,197	36,324	1,936,159	49,060	1,916,040	49,256	5,402,396	134,640
Total	3,640,818	65,866	3,853,098	81,083	3,391,380	63,358	10,885,296	210,307
Federal	2,053,706	14,652	1,913,766	18,091	1,389,016	12,619	5,356,488	45,362
Non-Federal	1,587,112	51,214	1,939,332	62,992	2,002,364	50,739	5,528,808	164,945
Associated Costs								
12. Thermal Electric Power	242,000	16,500	5,148,000	351,000	12,370,000	802,500	17,760,000	1,170,000
Total Associated Costs	242,000	16,500	5,148,000	351,000	12,370,000	802,500	17,760,000	1,170,000

1/ Relates only to new investment during period.
2/ Relates to total investment, 1970-2020.

Table 33–Summary of Costs, Framework Plan, Area D

Major Element	1970-1980 Investment	1970-1980 OM&R (Incr) 1/	1981-2000 Investment	1981-2000 OM&R (Incr) 1/	2001-2020 Investment	2001-2020 OM&R (Incr) 1/	1970-2020 Investment	1970-2020 OM&R 2/
				(in $1,000 units)				
Water Development & Control								
1. Electric Power	70,000	900	17,000	150			87,000	1,050
2. Navigation	148,500	12,700	364,000	28,800	202,200	20,200	714,700	61,700
3. Water Quality Control	367,100	14,319	274,696	1,418	321,595	3,724	963,391	19,461
4. M & I Water Supply	326,300	2,800	401,100	5,700	492,100	5,700	1,219,500	14,200
5. Flood Control	120,400	6,125	80,200	4,000	48,905	2,400	249,505	12,525
6. Irrigation	109,125	2,684	34,662	629	83,720	972	227,507	4,285
7. Reservoir Storage	195,059	150	216,700	160	14,000	10	425,759	320
Subtotal	1,336,484	39,678	1,388,358	40,857	1,162,520	33,006	3,887,362	113,541
Water and Related Land Programs								
8. Fish & Wildlife	122,486	12,249	81,121	8,112	123,813	12,381	327,420	32,742
9. Recreation (Water Related)	425,815	8,373	507,770	11,636	849,930	18,902	1,783,515	38,911
10. Related Land Programs	733,713	4,268	1,090,027	3,762	1,022,209	3,859	2,845,949	11,889
11. Further Studies				(not estimated)				
Subtotal	1,282,014	24,890	1,678,918	23,510	1,995,952	35,142	4,956,884	83,542
Total	2,618,498	64,568	3,067,276	64,367	3,158,472	68,148	8,844,246	197,083
Federal	794,383	7,471	961,327	13,056	706,247	6,962	2,461,957	27,489
Non-Federal	1,824,115	57,097	2,105,949	51,311	2,452,225	61,186	6,382,289	169,594
Associated Costs								
12. Thermal Electric Power	225,000	16,500	3,050,000	208,000	8,700,000	592,000	11,975,000	816,500
Total Associated Costs	225,000	16,500	3,050,000	208,000	8,700,000	592,000	11,975,000	816,500

1/ Relates only to new investment during period
2/ Relates to total investment, 1970-2020.

WATER & RELATED LAND SITUATION

Water and land requirements to meet the region's share of the Nation's food and fiber needs are small in relation to the total resources available. However, because of seasonal differences in precipitation and streamflow and diversified instream uses, storage is often required to provide water for both instream and withdrawal purposes. There is a surplus of land suitable for intensive uses, but some land has climatic limitations or is situated some distance from the water supplies. Wildlife habitat is an important land use that is in direct competition with many developmental programs, and, in spite of the large land area, wildlife habitat becomes more critical with every acre lost to other uses. Recreation uses for camping, skiing, snowmobiling, etc., also often compete with wildlife.

Water Situation

Under 1970 conditions, the total average annual surface-water discharge of the region was 310,000 cfs (224 million acre-feet). In addition, Canada contributed another 74,000 cfs (54 million acre-feet) making a total of 384,000 cfs or 278 million acre-feet annually. Approximately 240,000 cfs (175.7 million acre-feet annually) were in the Columbia River system. This large quantity of water is not always available wherever needed because of areal distribution and the timing of runoff. For example, in the Columbia River only 185,000 (134 million acre-feet annually) of the 240,000 cfs are available 80 percent of the time and the minimum flow is only 166,000 cfs (121 million acre-feet annually) or two-thirds of the mean. In most of the other streams, the minimum year discharge is only 60 percent of the average. Also, in some of the larger and most small streams, the minimum is less than 25 percent of the long-term average. This introduces critical water shortages in many areas during the low flow period which often extends from July through the winter.

Ground water is also an important element in current and projected use. The region contains roughly 550 million acre-feet in the top 50 to 100 feet of the water-bearing strata. Gross annual recharge is estimated to be 129 million acre-feet annually. However, some of the water moves from surface to ground water two or three times in its travel so that the net annual recharge is probably on the order of 100 million acre-feet.

Total annual ground-water withdrawal is estimated to be about 4.9 million acre-feet in 1970, of which about 3.6 million acre-feet are for irrigation and 1.3 million acre-feet for municipal, industrial, and rural-domestic water supply. Ground-water withdrawals are estimated to increase to 10.6 million acre-feet by 2020, when depletions could be about 5 million acre-feet. About half of the estimated withdrawals and depletions would be in the Snake River Basin.

Figure 37 illustrates projected ground-water withdrawals and depletions to 2020 for the region, the upper Columbia River Basin, and the Snake River Basin.

Although the Pacific Northwest has large quantities of ground water, additional development would add little to total water supplies, and, in some places, could contribute to already critical streamflow conditions. This latter condition may be especially true in the Snake River Basin of southern Idaho where the bulk of the ground-water use takes place.

Because of the interrelationships, both surface and ground water are included in the following discussions of the projected water withdrawals and use.

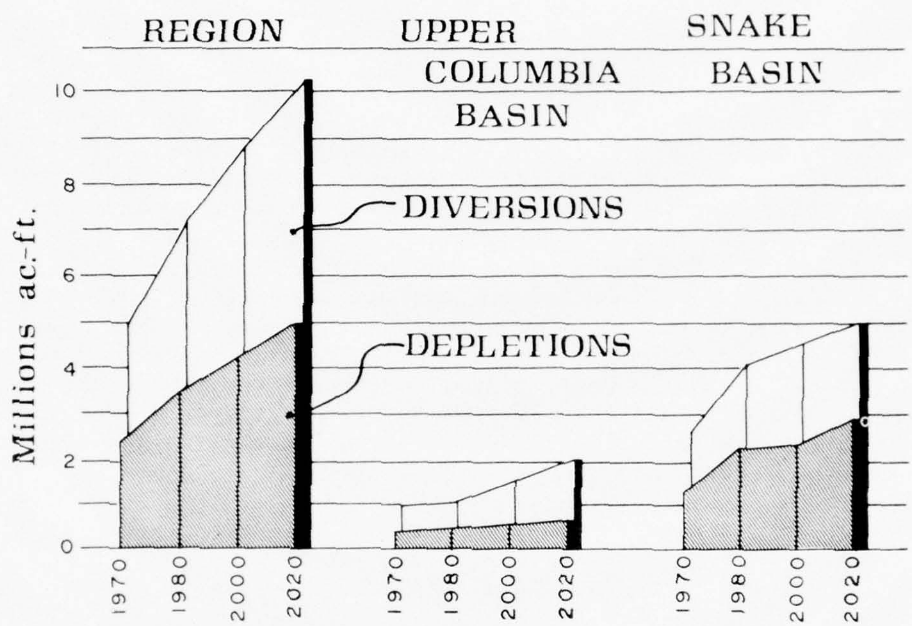


FIGURE 37. Projections of Ground Water Use

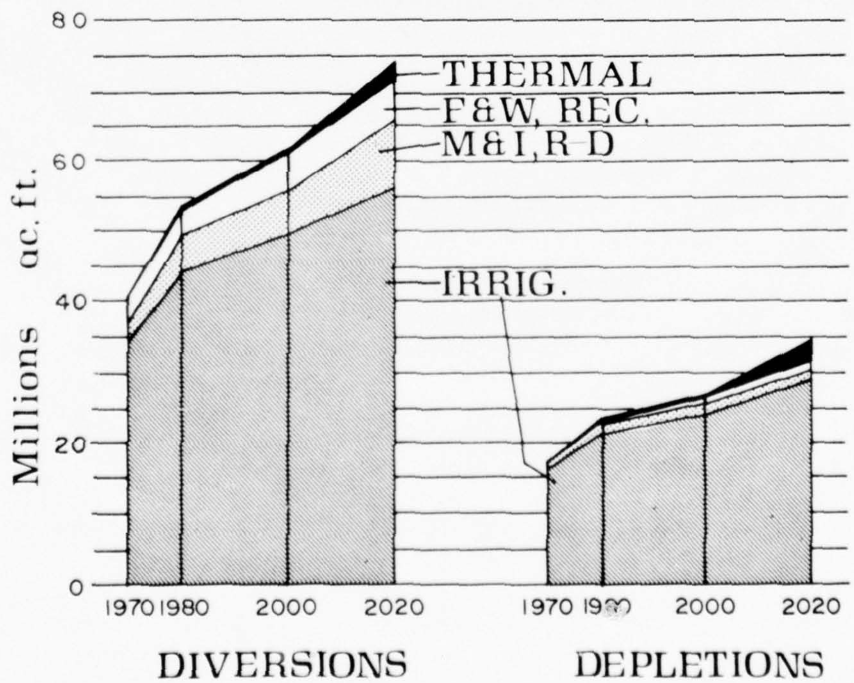


FIGURE 38. Water Use

Total withdrawal of water in 1970 approximated 41.0 million acre-feet of which 33.7 million acre-feet were used to irrigate 7.5 million acres of land. Municipal, industrial, and rural-domestic water supply, fish and wildlife, thermal power, and other uses required a withdrawal of 7.3 million acre-feet. The total depletion was estimated to be 16.9 million acre-feet, 86 percent of which was from surface supplies. Figure 38 illustrates the current and projected withdrawals and depletions by major uses.

Estimates of water withdrawals were made to meet the projected population, industrial, and food and fiber needs. Withdrawals for irrigation would increase to 56.7 million acre-feet by 2020; withdrawals for other purposes would reach about 18.7 million acre-feet by 2020. Depletions by 2020 are estimated at 33.6 million acre-feet, 85 percent of which would be from surface water. Irrigation would cause 83.5 percent of these depletions. About 5.5 percent of the depletions would result from municipal, industrial, and rural-domestic water supplies, 2.6 percent from fish and wildlife, and 6.5 percent from thermal power.

Table 34 summarizes the planned water withdrawals and depletions for ground and surface water by time period. Figure 39 gives these data for the Columbia River, upper Columbia, and Snake River as compared to available flows on an average annual basis. The chart for the Snake River shows a situation where total withdrawals exceed normal streamflows because of reuse of return flows.

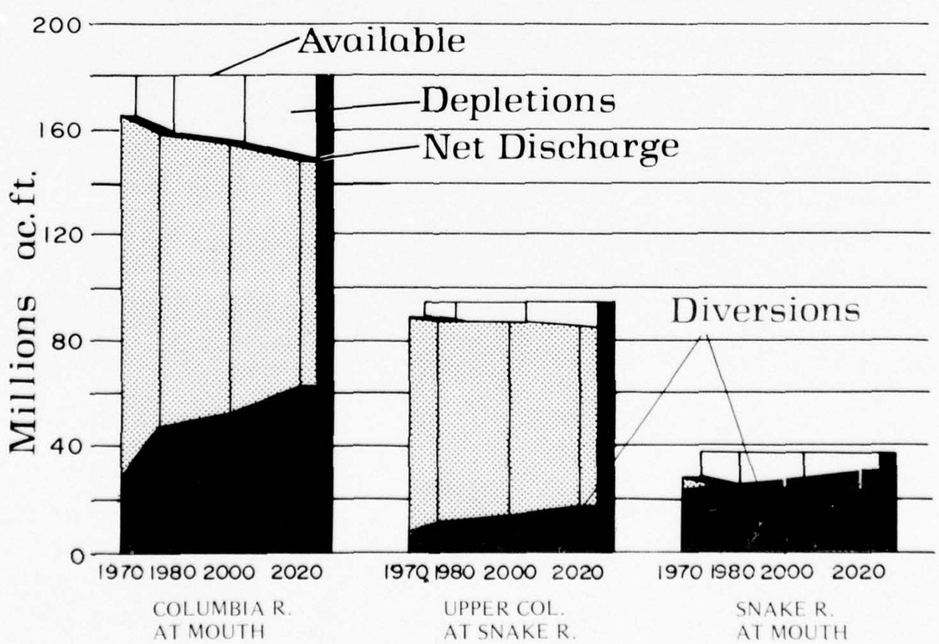


FIGURE 39. Water Supplies, Withdrawals, and Depletions

Table 34—Summary of Water Withdrawals and Depletions
Columbia-North Pacific Region

Use	Ground				Surface				Total			
	1970	1980	2000	2020	1970	1980	2000	2020	1970	1980	2000	2020
						(1,000 ac-ft)						
						Withdrawals						
Municipal	507	681	1,022	1,507	624	926	1,440	2,320	1,131	1,607	2,462	3,827
Industrial	622	787	1,104	1,454	1,520	2,017	2,978	3,958	2.142	2,804	4,082	5,412
Rural-Domestic	217	255	320	395	19	25	34	41	236	280	354	436
Irrigation	3,561	5,371	6,084	7,066	30,178	39,131	43,396	49,606	33,739	44,502	49,480	56,672
Thermal Power	0	0	0	0	824	116	747	2,143	824	116	747	2,143
Fish & Wildlife	17	76	138	167	2,921	3,653	4,372	5,858	2,938	3,729	4,510	6,025
Water Quality	0	87	44	47	0	0	0	0	0	87	44	47
Total	4,924	7,257	8,712	10,636	36,086	45,868	52,967	63,926	41,010	53,125	61,679	74,562
						Depletions						
Municipal	103	141	210	309	127	186	290	464	230	327	500	773
Industrial	103	134	190	243	259	342	514	692	362	476	704	935
Rural-Domestic	70	83	102	128	8	9	12	15	78	92	114	143
Irrigation	2,073	3,148	3,582	4,226	13,701	18,615	20,747	24,541	15,774	21,763	24,329	28,767
Thermal Power	0	0	0	0	24	116	747	2,143	24	116	747	2,143
Fish & Wildlife	10	29	53	68	376	501	617	804	386	530	670	872
Water Quality	0	0	0	0	0	0	0	0	0	0	0	0
Total	2,359	3,535	4,137	4,974	14,495	19,769	22,927	28,659	16,854	23,304	27,064	33,633

Total withdrawals from the Columbia River system were estimated to be 37 million acre-feet in 1970 and projected to reach 48.6 million acre-feet by 1980, 55.1 by 2000, and 65.3 by 2020. The depletion by 2020 was estimated to reach 30.3 million acre-feet. The application of this depletion to the flow available 80 percent of the time would reduce it from 134 million acre-feet to 118 million acre-feet, more than 3 million acre-feet below the minimum yearly discharge of 121 million acre-feet.

Total withdrawals from the Snake River Basin were estimated to be 21.8 million acre-feet in 1970, 26.6 million acre-feet by 1980, 28.5 million acre-feet by 2000, and 31.1 million acre-feet by 2020. In 2020, 82.5 percent of withdrawals would be from surface water. The depletion by 2020 was estimated at 13.7 million acre-feet, an increase of 5.1 million acre-feet over 1970 conditions. Applying this depletion to the flow available 80 percent of the time would reduce it from 25.5 million acre-feet to 20 million acre-feet.

Consideration of flows on this basis leaves the impression that large quantities of water are available annually. This is not a true picture because of areal distribution and the timing of runoff. For example, the average annual flow of the Snake River at Weiser in 1970 was 15,070 cfs. By 2020, projected irrigation and other upstream developments could reduce the average annual flow at Weiser to between 9,000 and 9,600 cfs. In addition, it is estimated that 903,000 acres of presently irrigated lands upstream are water-short. Based on average flows alone, serious conflicts would arise between irrigation diversions and instream needs. When considering the limited upstream storage opportunities and flows during dry periods, the conflict is even more serious. Therefore, a detailed study of the Snake River Basin is proposed to evaluate the potential for additional storage and ground-water withdrawals with full consideration for maintaining instream flows.

Instream use of water is of paramount importance to the region where it is used repeatedly for hydroelectric power production, recreation, navigation, fish, wildlife, esthetics, and water quality control. The importance of these uses to the people of the region and the Nation cannot be overemphasized. Flowing waters in the stream represent an important part of the region's natural environment.

Hydroelectric power is the dominant manmade instream use. Water in the Columbia River at the Canadian border passes through 11 hydroelectric plants before entering the Pacific Ocean. The regional hydroelectric generating capacity will exceed 23,000 MW when the projects under construction are completed. The total ultimate capacity of existing plants is about 34,000 MW.

The instream recreation uses involve boating, swimming, fishing, water skiing, and sightseeing. Water-related recreation use is expected to increase from about 89 million recreation days to more than 511 million in 2020. Based on water surface requirements for these recreation activities, an estimated 1.9 million acres of water surface will be used by 2020. The region's streams, lakes,

and estuaries have always been the habitat for many species of fish, waterfowl, fur-bearing and other animals, birds, and, in the case of estuaries, shellfish. Sport fishing alone represented over 21 million user days in 1965. By 2020, sport fishing is estimated to increase to 64 million user days, three times the 1965 use. Present commercial anadromous fish landings of nearly 45 million pounds are expected to reach almost 134 million pounds by 2020, much of which must be produced in area waters.

The Columbia, Willamette, and Snake Rivers carry almost 19 million tons of commerce annually. Total commerce on these rivers is projected to increase to over 33 million tons annually by 2020. Flows of at least 77,000 cfs below the mouth of the Willamette River and of 58,000 cfs below Bonneville Dam are required for navigation. Commercial navigation on the Willamette River is based on a flow of 6,000 cfs below the mouth of the Santiam River. Navigation is also important on the tidal reaches of many of the coastal streams.

Land Situation

The land resources generally are adequate to meet projected needs and to retain the area's environmental characteristics. The plan attempts to meet projected needs with the least detrimental effect on the environment and nonrenewable resources. A summary of projected cover and land use acreages used in the plan is contained in table 35 by time period and use.

Table 35–Summary of Planned Cover and Land Use
Columbia-North Pacific Region

	Area A				Area B			
	1970	1980	2000	2020	1970	1980	2000	2020
	(1,000 acres)							
Area Cover & Land Use								
Rangeland	7,817	7,288	7,233	6,965	35,437	34,734	34,593	34,283
Forest Land	25,403	25,242	25,117	24,926	22,025	21,939	21,842	21,715
Commercial	(21,579)	(21,418)	21,293)	(21,102)	(15,591)	(15,516)	(15,420)	(15,322)
Noncommercial	(3,824)	(3,824)	(3,824)	(3,824)	(6,434)	(6,423)	(6,422)	(6,393)
Cropland	5,547	5,912	5,820	5,998	8,488	9,046	9,102	9,348
Irrigated	(1,662)	(2,611)	(2,925)	(3,736)	(4,099)	(5,174)	(5,537)	(6,251)
Nonirrigated	(3,885)	(3,301)	(2,895)	(2,262)	(4,389)	(3,872)	(3,565)	(3,097)
Other Land	1,984	2,119	2,299	2,479	2,501	2,596	2,715	2,839
Urban & Industrial	(372)	(396)	(432)	(476)	(229)	(247)	(271)	(298)
Remainder	(1,612)	(1,723)	(1,867)	(2,003)	(2,272)	(2,349)	(2,444)	(2,541)
Total Land Area	40,751	40,561	40,469	40,368	68,451	68,315	68,252	68,185
Water Surfaces	769	959	1,051	1,152	517	653	716	783
Total Area	41,520	41,520	41,520	41,520	68,968	68,968	68,968	68,968
Ancillary Land Uses								
Fish & Wildlife	38,767	38,442	38,170	37,889	65,950	65,719	65,537	65,346
Water Related Recreation								
Facility Development	9	16	23	41	6	12	20	36
Total Irrigated Area	1,843	2,690	3,010	3,850	4,226	5,311	5,701	6,441

The only real change in the land resource, as defined in this study, is an estimated reduction in land area from 173.7 to 172.8 million acres due to the construction of reservoirs. This is a loss from the land base of 0.5 percent.

Although almost 51.2 million acres are suitable for cropping, only 20.8 million acres are so used, and the plan calls for only a modest increase of 4 percent by 2020. The major change would be a shift from dry to irrigated cropland with irrigated cropland increasing about 84 percent and dry cropland decreasing 37 percent. About 40.2 million acres are potentially irrigable, but, by 2020, only 13.2 million acres (an increase of 6.0 million) would be irrigated under the plan.

There would be an increase in other land from 8.3 to 10.5 million acres in 2020, an increase of 26 percent. This increase would result from expansion of urban, industrial, transportation, and recreation uses, and small ponds and reservoirs.

The increases in crop and other lands are expected to be met largely at the expense of the forest and rangelands. Programs to offset this areal reduction and still meet the increased demands on these lands would consist mostly of more intensive management. Projections indicate the forest area would decline from 85.8 to 84.2 million acres by 2020, primarily commercial forest land; the 58.7 million acres of range would be reduced by 2.3 million in the same period.

Area C				Area D				Total			
1970	1980	2000	2020	1970	1980 (1,000 acres)	2000	2020	1970	1980	2000	2020
15,263	15,081	15,035	15,009	228	223	209	198	58,745	57,326	57,070	56,455
25,648	25,512	25,200	25,074	12,768	12,736	12,638	12,447	85,844	85,429	84,797	84,162
(22,511)	(22,395)	(22,116)	(22,045)	(10,687)	(10,655)	(10,557)	(10,367)	(70,368)	(69,984)	(69,386)	(68,836)
(3,137)	(3,117)	(3,084)	(3,029)	(2,081)	(2,081)	(2,081)	(2,080)	(15,476)	(15,445)	(15,411)	(15,326)
5,815	5,840	5,885	5,747	954	771	657	611	20,804	21,569	21,464	21,704
(1,249)	(1,804)	(2,340)	(2,778)	(122)	(241)	(305)	(389)	(7,132)	(9,830)	(11,107)	(13,154)
(4,566)	(4,036)	(3,545)	(2,969)	(832)	(530)	(352)	(222)	(13,672)	(11,739)	(10,357)	(8,550)
2,078	2,320	2,570	2,831	1,760	1,931	2,130	2,351	8,323	8,966	9,714	10,500
(723)	(791)	(877)	(981)	(663)	(735)	(826)	(941)	(1,987)	(2,169)	(2,406)	(2,696)
(1,355)	(1,529)	(1,693)	(1,850)	(1,097)	(1,196)	(1,304)	(1,410)	(6,336)	(6,797)	(7,308)	(7,804)
48,804	48,753	48,690	48,661	15,710	15,661	15,634	15,607	173,716	173,290	173,045	172,821
379	430	493	522	244	293	320	347	1,909	2,335	2,580	2,804
49,183	49,183	49,183	49,183	15,954	15,954	15,954	15,954	175,625	175,625	175,625	175,625
46,726	46,433	46,120	45,830	13,950	13,730	13,504	13,256	165,393	164,324	163,331	162,321
9	27	49	91	7	21	38	72	31	76	130	240
1,292	1,858	2,406	2,850	142	253	317	400	7,503	10,112	11,434	13,541

These shifts in land use and cover would also affect the ancillary uses. Water associated recreational land development is projected to expand 674 percent but the total land use shift would be small in comparison to the total area. Additional potential wilderness areas and land associated with wild, recreation, and scenic rivers are identified. The plan calls for studies to select those most appropriate to satisfy the local, state, and national interest.

The region contains significant big game, waterfowl, and upland bird habitat. The total natural land habitat is projected to decrease almost 2 percent as a result of expanded farming, water storage, recreation, urban and industrial uses. However, the plan provides for increased big game and bird populations per unit of land area due to intensive management measures. In areas where big game winter habitat is becoming scarce or critical, the plan points out the need to curtail competing land uses.

ALTERNATIVES

The formulation of the framework plan is premised on meeting needs derived from the March 1968 OBERS projections as modified by projections made in connection with comprehensive studies of Subregions 9 and 11. Because projected population, employment, and other economic parameters are based primarily on national projections made in 1968 (OBERS), the framework study does not reflect concepts such as zero population growth, curtailment of industrial growth, or reduced migration into the region. However, in the plan formulation process major alternatives directed toward economic efficiency, regional development, and environmental quality objectives were given equal consideration. Alternatives considered and plan elements selected to meet the needs of the four individual areas are presented in previous portions of this appendix. In the following text, only alternatives relating to the region as a whole are discussed.

Electric Power

Future power requirements are projected to increase more than 12 times between 1970 and 2020. To satisfy these needs, load resource analyses were made for two alternative systems as described under Regional Framework Plans and Programs. The framework plan for electric power closely approximates the minimum hydroelectric system except that it includes appropriate power installations at projects needed to meet other functions. The alternative plan for greater hydroelectric development would have included potential hydroelectric projects which are highly controversial because of environmental impacts or are not economically justified under present standards.

Regardless of the alternative selected, the satisfaction of future power needs will be a continuing problem. The benefits of electric power, for communication, for industry, and for home use are recognized by almost everyone and

are taken for granted. Still, every proposal for another powerplant, whether it be hydroelectric or thermal, brings a deluge of objections.

The projection of power requirements to 2020 is an extension of load growth experience which may not ensue. For example, there is little doubt that environmental pressures will increase the cost of producing electric power. Accepting the social responsibility for safeguarding the environment with higher costs could influence the location of industry, thus causing material changes in industrial loads. Also capital investments of industries sensitive to power costs may be slow pending stabilization of future power rates.

It also should be recognized that peaking resources, a regional mix of imported power and thermal and hydroplants, have many variables. Because of rapid technological advances, public views, and numerous pumped storage sites, more detailed studies are required to develop a realistic breakdown between peaking resources. In addition, alternative plans for electric power would also include consideration of alternative levels of use or production. Reduction of power requirements by increased efficiency, pricing, or policies should be explored.

Navigation

With excellent ports accessible both to the Pacific Ocean and the Columbia River waterway and the extensive rail and highway networks connecting to them, transportation by water is important to the region's economy. In order for inland waterways to perform their function of moving bulk commodities, both dry and liquid, land transportation, rail, highway, and pipeline must be linked to it in an effective and efficient manner. This aspect of commerce has many variables and alternatives and selection of the best plan from the standpoint of all the people entails a high degree of cooperation between ports, local governments, regional planning groups, private interests, and the several Federal agencies. This planning embraces a range of activities, from creation of entirely new port or waterfront complexes to rehabilitation and conversion of existing waterfront lands and facilities.

Because of the physical and geographical composition of waterborne commerce, major alternatives for waterborne commerce are rather limited. Foreign commerce is practically all ocean oriented, and the only real alternatives are shifts in major ports and the types of vessels. The protected and deep waters of the Puget Sound Subregion would accommodate nearly all future vessels. Vessels drawing less 40 feet would have free access to the lower Columbia River system. With that exception, potential changes in the ocean-going vessels would have little effect on the framework plan. In addition, the Columbia River and Subregion 11 are the only major navigation systems so no large shifts in the region's share of commerce between subregions are predicted.

The inland system, primarily the Columbia, lower Snake, and lower Willamette Rivers, is a significant asset to the economy, but two existing locks, Bonneville Dam and Willamette Falls, impose a physical limit on the quantity of future cargo movement. Similarly, if the alternatives of extending navigation on the Columbia River to Wenatchee and improving the Willamette River to Corvallis were not followed, more costly modes of transportation for certain bulk commerce would be an economic restraint, limiting the competitive advantages of these subregions. In potential structural developments of locks and channels, the major alternative is limited to either having or not having such a program.

The framework plan and programs include additional interdisciplinary studies to evaluate these alternatives.

Irrigation

Although some 7.5 million acres are new being irrigated, the region still has some 33 million acres of dry land suitable for irrigation. Approximately 43 percent of this potentially irrigable land is class 1 or 2, capable of producing high yields of all climatically adapted crops.

Two factors make evident the extremely wide range of alternatives for locating new irrigation: (1) 33 million acres of suitable land from which only 6 million acres need to be selected; (2) annual runoff of 278 million acre-feet but projected new depletions of only 13.4 million acre-feet.

Although most of the irrigated and irrigable lands are adjacent to major rivers, withdrawal of water for irrigation now and in the future can, and does, have major impacts on the operation of the rivers for other purposes. At some locations, such as the upper Snake River, decisions on the required instream flow would control the extent of irrigation. Irrigation could also be a significant factor in the operation of the Columbia River system, particularly during critical low-water years. Thus the location of new irrigation acreage could have a major effect on environmental quality and the general economy through additional costs or reduction in power output through depletions.

To assist in framework plan formulation, the regional irrigated acreage projections were distributed among the subregions by the Irrigation Committee as they expected it would most likely develop. The sequential order of future irrigation development to meet the growing food and fiber needs could follow a multitude of alternative patterns in addition to the one selected for framework planning purposes. For example, the acreage could be developed in Areas A and C with less environmental effect than major development in Area B, Snake River Basin.

The present trend toward irrigation development using private or non-Federal capital financed through loans or bonds indicates that feasibility in the financial market place is a prime consideration. A detailed economic study be-

yond the scope of this study would be helpful to the investor and aid in achieving a reasonable rate of irrigation development. The level B studies now being initiated should resolve many of the major irrigation alternatives.

Flood Control

The framework plan for major streams is a mix of nonstructural and structural measures to curtail increases in average annual flood damages of $70 million which now occur on 3.9 million acres of flood plains along the region's streams and tributaries.

Under nonstructural elements, the plan proposes flood plain regulations where appropriate to control future development, flood proofing to protect existing development where flood control works are not warranted or desirable at this time, and continuation and acceleration of existing Federal-State programs of flood forecasting and flood fighting. In addition, selected types of land measures and watershed treatment practices would greatly reduce damages along smaller streams and much of the land area. Structural measures were developed on the basis of judgment and preliminary estimates, recognizing that further analysis is needed to establish economic justification and order of priority.

The mix between nonstructural and structural choices presents a wide range of alternatives. The ultimate choice depends on:

Population and economic activities.

The feasibility of specific flood control measures.

The possibility of building multiple-purpose reservoirs with flood control as a function.

The sociological and environmental desires of the people, i.e., retention of stream in a "free-flowing" condition.

As in most other functions, the level B studies should narrow the field of alternatives and define specific problems and areas.

Fish and Wildlife

To maintain the present level of fishing, hunting, and recreational activities with the current degree of success and enjoyment will require improvement of water and land areas for habitat and human use. There are significant opportunities left for such enhancement. For example, in the State of Washington, three areas under investigation can add significantly to the anadromous fish resource. The Touchet Project will provide water for new salmon runs where presently there are none. In the White Salmon River, removal of the existing Condit Dam would

reestablish a salmon run that has been nonexistent for over 50 years. A similar opportunity exists in the Okanogan and Similkameen Rivers where removal of the Enloe Dam would admit salmon where they are presently barred.

Offstream pumped storage for peak power generation could provide a significant opportunity on many northwest streams for flow augmentation and temperature reduction in addition to power generation if planning and management programs are developed in harmony.

The Columbia Basin Project has provided outstanding hunting and fishing opportunities, accomplished without a fish and wildlife plan. With a plan, there is a large potential for the remaining half million acres of the project yet to be constructed.

These types of alternatives as well as many others should be evaluated in future studies. However, there are cases where the alternatives to be considered are whether the critical water and land areas should be preserved or continue to gradually be absorbed by urban expansion, highways, and other developments.

Outdoor Recreation

There are hundreds of square miles of potential recreation areas, including many acres of practically unused water surface. However, the recreation opportunities near population centers are becomming more limited each day. As in fish and wildlife habitat, choices need to be made and recreation areas assigned or dedicated while some opportunity still remains to develop urban recreation sites. The major alternatives in this function also appear to be choices requiring resolution of conflicting use.

Other Functions

Alternatives are not discussed for the functions of water quality control, municipal and industrial water supply, preservation and enhancement of natural environment, and related land programs, because the plans are sufficiently general to encompass a range of alternatives or because no major conflicts in meeting projected needs are apparent at this time.

COMPARISON WITH OTHER PROJECTIONS

The economic projections used in the Columbia-North Pacific Study (C-NP) were derived from a national-interregional projections program (OBERS) of the U.S. Water Resource Council dated March 1968. Projections for the comprehensive Type 2 studies of Puget Sound and Adjacent Waters and the Willamette Basin were substituted for OBERS projections for Subregions 9 and 11. The Type 2 projections used different assumptions and methodologies than OBERS for the same geographic

areas. A detailed comparison of these economic projections is made in the Addendum to Appendix VI, Economic Base & Projections. Appendix C of the comprehensive study of Willamette River Basin and Appendix XV of the study of Puget Sound and Adjacent Waters also contain comparison of their projections with those made by OBERS which demonstrate the effect on their plans and programs.

Table 36 compares the projections used in the Columbia-North Pacific study with the June 1969 OBERS for population and personal income by the region and subregions for each of the three time periods. Personal income was not derived for Subregion 11 as gross regional product was developed instead. Both indices generally follow the same growth pattern. The use of the June 1969 OBERS projections would decrease regional population forecasts 24 percent by 2020, with almost all of the change resulting from differences in Subregions 9 and 11.

The changes made by the June 1969 OBERS projections were in population, employment, and income. Although new projections for food and fiber were not made, it is expected there would have been a corresponding reduction in irrigation, land measures, watershed protection, or any phase of plan element based on food and fiber. However, there is no statistical basis available to estimate this change.

Water quality control, municipal and industrial water supply, fish and wildlife, and outdoor recreation are mainly related to population and to industries having similar growth trends. These components of the framework would be reduced 8 percent by 1980, 14 percent by 2000, and 24 percent by 2020.

Electric Power is projected on the basis of population and on the assumptions of continued industrial growth and power costs lower than national average. The effect of using June 1969 OBERS projections is shown in table 37.

Estimates of waterborne commerce considered production and consumption of commodities, historical trends, locational factors of origin and destination of commodity movements which would affect diversion of traffic between transportation modes and the location of markets and sources of raw materials. A major portion of this traffic is related to food and fiber requirement or to national or international trends of supply, demand, and transportation preferences. Consequently, the use of the June 1969 OBERS projections would have little effect on the navigation features in the framework plans and programs.

Flood damages were projected at the growth rates for total personal income and other economic growth parameters. Agricultural damages were projected on the basis of anticipated crop yields. Allowances were made for changes in land use where such could be foreseen. Thus projected flood damages, the principal measure of need for flood control works, were not materially affected by use of the 1969 OBERS projections. Further, much of the flood control program was scheduled prior to 2000 when differences among the projections were small.

Table 36–Comparison of Projections
Columbia-North Pacific Region

Sub-region	Time Period	Population: C-NP	Population: OBERS June 1969	Population: % Change from C-NP	Total Personal Income[1/]: C-NP	Total Personal Income[1/]: OBERS June 1969	Total Personal Income[1/]: % Change from C-NP
1	1980	699,100	649,900	-7.1	2,759,321	2,522,422	-8.6
	2000	897,050	842,000	-6.1	6,112,972	5,699,859	-7.3
	2020	1,140,360	1,086,200	-4.8	13,241,159	12,558,861	-5.1
2	1980	253,040	231,900	-8.4	1,040,513	920,941	-11.5
	2000	334,020	300,300	-10.2	2,391,910	2,113,269	-11.7
	2020	431,270	384,600	-10.8	5,352,504	4,772,985	-10.3
3	1980	280,730	268,900	-4.2	1,108,791	1,060,109	-4.4
	2000	355,200	338,500	-4.7	2,437,816	2,406,436	-1.3
	2020	443,730	425,600	-4.1	5,322,167	5,310,193	-0.2
4	1980	350,870	353,900	+0.9	1,216,921	1,264,918	+3.9
	2000	450,540	458,100	+1.7	2,707,857	2,952,454	+9.0
	2020	576,000	590,600	+2.5	6,057,552	6,780,175	+11.9
5	1980	328,690	339,100	+3.1	1,263,503	1,257,358	-0.5
	2000	430,400	450,200	+4.6	2,912,517	2,887,628	-0.9
	2020	553,480	586,000	+5.9	6,559,798	6,516,933	-0.7
6	1980	193,460	188,200	-2.7	729,348	661,910	-9.3
	2000	234,640	228,000	-2.8	1,555,513	1,473,547	-5.3
	2020	274,320	276,600	+0.8	3,263,627	3,216,320	-1.5
7	1980	251,430	242,900	-3.4	1,039,347	992,753	-4.4
	2000	321,870	301,300	-6.4	2,326,301	2,135,981	-8.2
	2020	404,370	366,600	-9.4	5,065,945	4,482,260	-11.5
8	1980	277,910	265,438	-4.5	1,114,890	1,039,312	-6.8
	2000	349,370	330,038	-5.6	2,453,383	2,275,515	-7.2
	2020	441,320	404,592	-8.3	5,422,555	4,757,442	-12.3
9	1980	1,767,500	1,500,868	-15.1	6,478,000	6,244,840	-3.6
	2000	2,422,000	2,006,762	-17.1	13,720,000	14,384,389	+4.8
	2020	3,591,000	2,587,808	-27.9	31,240,000	31,787,760	+1.8
10	1980	465,480	474,000	+1.8	1,652,375	1,741,234	+5.4
	2000	575,420	580,400	+0.9	3,600,986	3,730,199	+3.6
	2020	708,880	709,200	+0.1	7,794,152	8,141,054	+4.5
11	1980	2,726,900	2,455,800	-9.9	-	10,921,125	-
	2000	4,300,500	3,352,600	-22.0	-	24,982,718	-
	2020	6,809,400	4,352,100	-36.0	-	55,958,397	-
12	1980	16,250	15,700	-3.4	68,949	65,883	-4.5
	2000	18,670	18,100	-3.1	139,416	129,421	-7.2
	2020	21,320	20,200	-5.3	274,554	250,491	-8.8
Region	1980	7,611,360	6,988,813	-8.2	18,471,958[1/]	17,771,680[1/]	-3.8
	2000	10,689,680	9,210,083	-13.9	40,358,671[1/]	40,188,698[1/]	-0.4
	2020	15,395,450	11,789,880	-23.5	89,594,013[1/]	88,744,474[1/]	-0.9

1/ Exclusive of Subregion 11 where personal income data were not available.

Table 37–Comparison of Projected Electric Power Requirements
Columbia-North Pacific Region

Year	Energy C-NP	Energy 1969 OBERS	Capacity C-NP	Capacity 1969 OBERS
	(millions kwh)		(mw)	
1980	193,200	193,200	34,400	34,400
2000	512,000	462,800	91,300	81,615
2020	1,286,000	1,032,000	229,400	178,960

POTENTIAL FRAMEWORK PLAN ACCOMPLISHMENTS & EFFECTS

As implementation of the framework plans and programs would meet most of the projected water and related land needs of the region, the potential economic and environmental accomplishments would be major. Only minimum undesirable effects on the natural environment would result from the framework plans and programs because they were formulated with full recognition of environmental values, with the intent to minimize or mitigate adverse impacts on the natural environment and to preserve prime recreation, fish producing, wildlife, and esthetic areas.

In most of the region, opportunities were available to meet most of the identified needs. However, in the Snake River Basin it would not be feasible to provide a full water supply to all of the presently irrigated water-short lands, to preserve all of the prime recreation streams and, at the same time, provide optimum streamflows for aquatic life and water quality. From the standpoint of the overall well-being of the area, the unmet portions of these needs are not considered particularly significant. The food production lost by not providing full supplemental supplies could be replaced through accelerated management techniques on presently irrigated lands or by an increase in new irrigation either in that area or elsewhere in the region.

The following discusses potential accomplishments and some of the effects.

Environmental and esthetic values would be preserved and enhanced by:

The establishment of realistic minimum flows on all streams, and augmentation of low flows in many areas to improve esthetic values, fish and wildlife habitat, and to aid in pollution control.

The designation of additional scenic roads from some 7,500 miles of highway identified as having potential.

The designation of additions to the state or national system of recreation streams from over 10,500 miles of all or part of nearly 200 streams identified as having potentials for inclusion.

Landscape management and control.

Measures for water quality, flood plain management, fish and wildlife, recreation, and watershed management and treatments as described in subsequent narrative.

The effects of measures to preserve and enhance the environmental and esthetic qualities of the region would be to provide a more desirable balance between man's economic and social well-being and his environment. However, these accomplishments would not be without some sacrifice from the economic or social standpoint or, in some cases, of some facets of the environment.

The establishment of minimum flows would preclude further diversions for any purpose when the natural flow drops to some established minimum, except for withdrawals under senior rights or from storage releases. Setting minimum flows will not, in itself, improve stream conditions, except where senior diversion rights are later abandoned or extinguished. The principal benefit would be to prevent further low-flow depletions.

Increased minimum flows, through releases from storage, transbasin diversions, or ground-water pumping, would generally benefit the appearance, water quality, and aquatic life of a stream. In addition, most other instream uses such as commercial and recreational navigation and hydroelectric power production would be benefited. Diversions would also be facilitated through reduced pumping lifts or improved diversion conditions. All of the adverse effects associated with storage, transbasin diversion, or ground-water pumping required to achieve these flows would be chargeable to flow augmentation. In addition, since augmentation flows are usually protected from diversion, any out-of-stream use to which the water might be put would be precluded.

Designation of additional recreation streams and scenic roads along streams would preserve or improve the view by preventing indiscriminate housing and commercial developments, billboards, water developments, timber cutting, and other incompatible uses. Adjacent wildlife habitat would be preserved to some extent, and much needed recreational opportunities would be possible. The recreation stream designation would also assist in preserving instream water quality and aquatic life. However, values of private land along roads and streams may suffer and several thousand acres of timber harvest would be prevented. In the case of recreation streams, potential upstream water developments may be precluded through prohibition of flow control or diversion. In some instances, this could preclude desirable low-flow augmentation. Also the designation of a large number of streams only for recreation use could constrain some segments of the economy by placing restraints on competitive development.

Landscape management and control measures and programs would minimize adverse environmental effects of development and preserve the scenic, historic, and cultural values. The use of coastal, high alpine, and desert areas would be controlled to prevent damage or destruction of their fragile ecosystems by human use. Although this management and control would make some developments more costly, the retention of the unique attractions and liveability of the region should more than offset such costs.

Electric power would be provided by:

The installation of 14,300 MW of additional capacity at existing and new hydroelectric plants and 143,700 MW of thermal power by 2020.

Installation by 2020 of an estimated 62,100 MW of additional peaking power developed from pumped storage and thermal sources. Further studies are necessary to determine the breakdown.

The principal beneficial effect of expanded electric power production would be the meeting of a significant portion of the region's growing energy requirements from convenient and relatively clean sources. As this region is poor in other forms of energy, electricity is called upon to heat more homes, cook more meals, and power more machines than in most other localities. In the future, it will be called upon to assist in waste disposal and control of pollution which, to this extent, has a favorable environmental impact. Most of the added conventional hydro capacity would result from expansion of existing plants, minimizing the adverse effects of additional dams and reservoirs. A few of the conventional hydroplants and all of the pumped storage and thermal plants would require development of new sites with losses in natural environmental values.

Greater transmission capacity would be required throughout the region. In order to minimize the opening of new corridors, existing lines would be reconductored to higher voltages. However, new lines would be required, especially between new generating plants and major load centers. Lines should be located to provide maximum screening from view and the generating plants should be located close to the major loads to minimize transmission distances.

The electric power needs cannot, however, be met without some degradation of the natural environment. The transition from essentially hydro generation to a hydro-thermal system, with hydro used increasingly for peaking, would result in greater downstream flow fluctuations. These fluctuations generally would not be of major concern where a plant discharges directly into a reservoir or other slack water. Otherwise problems could arise for navigation, fish and wildlife, and recreation.

Powerplants and transmission lines would occupy land that could be used for other purposes or left in its natural state. The framework plan is considered to have a minimum of such undesired effects, and environmental impact studies are required for all elements of the plan before they can be implemented.

Commercial water transportation needs would be met by:

Deepening the lower Columbia River channel and other deep and shallow-draft channels totaling 436 miles, and construction of 16 miles of breakwater by 2020. Over half of the channel work would be in Subregions 8 and 9. All breakwaters would be in Subregions 10 and 11.

Enlargement of the existing Bonneville and Willamette Falls locks, extension of barge navigation on the upper Columbia River by channel improvements, and construction of three new locks in existing dams if found to be acceptable by recommended interdisciplinary studies.

Expansion of commercial port facilities along the existing and planned navigation channels and addition of moorage and launching facilities for small boats in all subregions.

Future port expansions and modifications would be based on a regional port study which would evaluate the effects of changing shipping technology on commodity movements, determine future port requirements, and the means to accommodate these requirements.

Foreign and domestic commerce is an important segment of the economy, providing export of agricultural and forest production and the importation of consumer goods and raw materials for manufacture. Also, pleasure boating is a major recreational asset which also supplies economic gains. The framework plan would aid the use of the navigation assets, but at the same time navigation improvements usually would have some effects on marine and estuarine environment. Dredging and dredge waste disposal and shoreline development including backup areas for port terminal facilities and water transport-oriented industry could result in ecological changes in areas immediately affected. However, dredge disposal would be carefully planned and would be subject to strict State and Federal control to minimize adverse effects. Land required for navigation generally would be satisfied by expansion of existing facilities and use of areas already partially or wholly developed. Small boat harbors in naturally protected bays and inlets would require planned dredge disposal, control of pollution, and care in the design and construction to minimize disruption of the marine ecology. The hazards of vessel collisions and oil spills would be reduced by management programs.

Because of the quantities of spoil involved, a primary area of concern would be deepening and maintaining the lower Columbia River deep-draft channel.

Spoil disposal must be carefully controlled to prevent unnecessary damage to the environment.

The potential extension of navigation to Wenatchee requires careful consideration of environmental impacts. The addition of locks would have no effect, but intermittent channel dredging would be required in spawning grounds of anadromous fish along the 57-mile reach of open river below Priest Rapids Dam. These factors would be considered in the recommended additional studies.

Water quality would be maintained or improved by:

Waste treatment to remove 85 percent of organic wastes from municipal and industrial effluents by 1980, and 90 percent by 2000 in all areas except some marine waters of the Puget Sound area where treatment levels will be determined by ongoing Federal-State studies.

Using cooling ponds, towers, or mechanical draft cooling to eliminate any discharge of warm water into fresh water streams or lakes by thermal electric powerplants.

Land treatment measures and increased irrigation efficiency to reduce stream sediment loads and the amount of agricultural return flow.

Water quality improvement would benefit fish life, instream recreation and wildlife, domestic and industrial water users, and the general environment. Removal of organic waste and bacterial contamination (generally problems near urban centers) would permit safe water-based recreation in areas of greatest demand, and increase dissolved oxygen to the benefit of fish life.

Prevention of warm water discharges into streams and lakes from thermal electric plants or other sources would assist in maintaining water temperatures more nearly satisfactory for fish.

Land measures that reduce surface runoff and the attendant erosion, would reduce sediment loads and the amount of natural and manmade nutrients entering the streams. As a result, aquatic growth would be reduced, improving the streams' appearance and water quality. Elimination of these growths would also reduce taste and odor problems, minimize clogging of diversions, and cut down on diurnal dissolved oxygen fluctuations.

Municipal, industrial, and rural-domestic water supplies would be provided primarily by:

Additional development of existing sources and development of some new sources to permit the withdrawal of an additional 6,166,000 acre-feet by 2020. About 67 percent would come from surface supplies.

The primary effect of these developments would be to insure an adequate supply for the region's municipalities, industries, and rural-domestic users. The planned withdrawals would affect streamflows or ground-water levels; but, in most instances, these would be negligible. Reservoirs, pumping plants or other diversion structures, and delivery pipelines or canals would be required in most instances to regulate and deliver the water. In some cases, central supply and distribution would be needed to obtain economics of scale and to minimize possible adverse impacts on the environment and the water resource.

Flood control would be provided by:

Flood plain management including flood plain regulation, flood information reports, and flood proofing at 148 locations; 1,300 miles of levees and channelization; 12,000 acre-feet of single-purpose flood control storage; and some 17.1 million acre-feet of joint-use storage which would be used for flood control. Significant reductions in bank erosion and flood damages along minor streams would also be provided by erosion control, levees, and channel work as subsequently described under Related Programs.

The intent of this planning was to hold disruption of, or damage to, the environment to a minimum while providing the necessary flood control. While recognizing that storage provides optimum control of flooding and contributes to improvement of downstream river segments, the plan uses a minimum of storage because of its effects on the natural environment in the reservoir areas. The framework plan relies heavily on nonstructural measures which would regulate intensive development in the flood plains through zoning, consistent with the degree of protection provided and the desirable land use pattern. Wherever possible, levees would be set back away from the streambanks and the intervening area preserved as a "greenbelt."

Food and fiber production needs would be met by:

Increased yields from all cropland through improved crop strains and better farming practices, including additional irrigation.

Furnishing adequate water for 1.5 million acres of presently irrigated water-short land and over 6 million acres of new irrigated land to supply 42.4 million tons of additional production.

Better range management and conservation practices to increase the grazing capacity of rangeland by 4.6 million animal unit months on 2.3 million fewer acres than now available.

Programs and practices on forest land to increase fiber production by 1,071 million cubic feet, from 1.7 million fewer acres than now available.

As the total projected food and fiber needs would be met, past trends of economic growth would be continued. The region would continue to supply its share for use of the Nation and export. The principal effect would be conversion of cropland from dry to irrigated, with greenbelts provided among the fields for the benefit of wildlife.

The use of water for irrigation would change the environment of natural streams where water would be diverted. The storage of excess winter flows for irrigation and other purposes can be an advantage in reaches of streams where insufficient summer flows are augmented by releases. Shifts in land use and even changes in crops can cause changes in the natural environment.

The programs and practices included in the framework plan would provide for the management of water and related land in a manner so as to avoid the bad features of the past such as erosion, overgrazing, harvest of forests without stocking, and low quality irrigation water return flows.

Storage facilities would include:

Multiple-purpose reservoirs containing about 17 million acre-feet, three single-purpose flood detention reservoirs totaling 12,000 acre-feet, and nearly 70,000 ponds with about 531,000 acre-feet of generally multiple-purpose storage.

The bulk of stored water would be used for irrigation. Other purposes for which storage would be used include: flood control, recreation, water quality, electric power, navigation, and fish. The final location and scoping of most of this storage requires additional studies. Any water quality storage would be reviewed in implementation studies on the basis of current Federal policy.

The planned storage, exclusive of small single-purpose reservoirs and ponds, would include the enlargement or modification of seven existing reservoirs to develop 660,000 acre-feet of storage, the construction of about 250 small headwater storage projects to develop about 3-2/3 million acre-feet and over 1 million acre-feet of offstream storage. Of the remaining 11-3/4 million acre-feet in about 70 large storage developments, nearly 6 million acre-feet are included in alternative plans for subareas recommended for interdisciplinary studies to select the best plan.

The use of existing facilities, the inclusion of small headwater storage and offstream storage, and the recommendation that most of the potential large storage be considered only as the result of detailed studies limit and control the possible adverse environmental impacts. Several large potential storage projects were rejected because of their adverse environmental effects. However, there are undesirable impacts which cannot be avoided. Except in the instances of offstream sites, slack water would be substituted for a free-flowing stream, and fish movement would be restricted or stopped. The reservoir pool would sometimes inundate wildlife habitat and migration routes, productive timber lands, private developments, or transportation facilities.

Some of the adverse effects of storage could be mitigated through replacement or relocation, but others could not. Consequently, streams identified as being potential additions to the wild and scenic rivers system were avoided wherever possible, as were anadromous fish streams, key wildlife habitat areas, and unique natural or scenic areas. Insofar as possible, the planned storage would represent a balance between preservation and development.

Each reservoir was included to assist in meeting existing or projected water and related land needs with the least total adverse effects. As no storage can be developed without some undesirable consequences, each major storage development was considered from the standpoint of serving multiple uses wherever possible, together with the complimentary effects of other types of developments or measures in order to minimize the number and size of reservoirs.

A substantial part of the Nation's projected increased food needs expected from the region could only be provided through expansion of the irrigated acreage and the firming up of water supplies to currently irrigated, but water-short areas. Nearly all of the additional reservoirs would contribute to this need. The same storage would, in most cases, also assist in reducing flood damages through control of high flows, and provide a place for slack-water recreation and fishing. Most of the major reservoirs in Areas C and D also would provide water for municipal and industrial use.

Although hydroelectric power would be developed only at a few of the larger new reservoirs, these developments would provide a relatively clean source of energy. A few of the reservoirs could also contribute significantly to downstream water quality, particularly in areas with critical problems such as Crab Creek, Spokane, Boise, and Grande Ronde Rivers. Releases for improved water quality would benefit the streams' appearance, aquatic life, recreational use, as well as other uses of the water.

Recreation needs would be met by:

Providing for an additional 422 million water-related recreation days by 2020 through facility development on an additional 208,900 acres of land and the use of 1,870,000 acres of water surface as compared to the present need for only 368,000 acres of water.

Acquiring about 98,000 acres of land primarily for urban recreation.

Study of 2.7 million acres of land to determine those portions which should be designated as wilderness or primitive areas.

Because there are more than 2.5 million acres of fresh water surface and ample land area, the planned increase in water-related recreation would have little economic or environmental effect in most parts of the region.

However, some loss of the natural environment would occur in the process of constructing facilities for campgrounds, picnic areas, and on beaches for swimming and boating.

Similarly, expansion of wilderness and primitive areas would curtail the available timber supply for lumber and pulp and paper products. This supply is already critical and further reduction of the timber resource would compound the problem of meeting the projected needs.

Fish and wildlife needs would be met by:

Preservation and protection of fish habitat on nearly 14,000 miles of streams; improvement of habitat on 33,400 miles of streams and 422,000 acres of lakes; augmentation of the supply of fish by enlarging existing hatcheries, building 144 new hatcheries and providing 11,000 acres of rearing ponds; and providing access to 9,851 miles of streams at 1,407 sites on lakes, and at 472 sites on salt water.

Land acquisition or control of an additional 3.8 million acres for specific wildlife preservation and management; improvement of wildlife habitat on 10.1 million acres; and annual production of 680,000 game birds. Access would be improved to nearly 60 million acres.

Management and development practices on greatly accelerated basis as required to meet the projected needs.

These and other related activities would provide an additional 42.8 million user-days of fishing between 1970 and 2020 and 13.1 million user-days of hunting. Fish and wildlife features are designed to enhance the natural environment and the public's enjoyment of it. Minimum streamflows necessary to maintain present fish production levels would be determined and controlled to protect the resource. Artificial propagation facilities would augment natural stream rearing of salmon, steelhead, and trout. Passage facilities would be installed at natural and manmade barriers to allow greater use of the area's waters by anadromous fish. Big game, waterfowl, and upland bird habitat would be improved, controlled, and acquired to increase carrying capacity, and upland bird propagation facilities constructed.

Related land programs would satisfy the needs by:

Erosion and sediment control on 32 million acres; water yield improvement on 612,000 acres of forest land; water conservation on over 6 million acres; protection and management on nearly 100 million acres; drainage on 1,347,000 cropland acres; 17,100 miles of bank stabilization; 4,289 miles of dikes and levees; channel improvements on nearly 29,000 miles; 110,000 detention and check structures and nearly 70,000 ponds and small reservoirs.

Full consideration would be given to environmental values as part of the evaluation process in implementation studies of channels or structures affecting streams.

This large related land program provides for the conservation of land and water resources under the conditions resulting from the pressure to produce the projected food and fiber needs. The control of erosion and sediment, conservation of water, protection and management of forest and rangeland, bank stabilization, and detention and check structures would retain both the quantity and quality of water and related land. Water yield improvement, cropland drainage, ponds and small headwater reservoirs would increase the availability of water and tend to stabilize flow conditions. Dikes and levees and some channel modifications would reduce flood damages. Most of the channel adjustment practices would be on forest land; they would consist primarily of the snagging of log jams. The passage of anadromous fish would be improved and bank erosion would be reduced.

One of the most important products of the study is the identification of complex problems warranting further investigations.

The framework plan includes:

Studies of the coastal zone and estuaries to develop a coordinated plan.

Studies of 896 watersheds to select those which are justified and desired by local interests.

Studies of 14 river basins or subareas to select the best alternatives where there are complex problems, a wide array of alternatives, and lack of available data.

Special studies to obtain facts for planning.

IMPLEMENTATION OF FRAMEWORK PLANS AND PROGRAMS

GENERAL

This study provides a flexible framework of plans and programs as a first step in a sequence of comprehensive planning efforts. A framework is evolved which provides a direction towards more detailed studies by giving the planner broad scale analyses of water and related land resources, the probable nature and extent of problems, cost, and timing of possible measures for their solutions. This direction will provide all interests with a guide for the best management, use, development, and preservation of the water and related land resources of the Northwest as well as supplying a basis for accomplishing further planning where it is urgently needed.

These framework plans and programs form a basis for the comprehensive joint plan for Federal, State, interstate, local, and nongovernmental development of water and related land resources being prepared by the Pacific Northwest River Basins Commission pursuant to Title II, section 201(b) (2) of Public Law 89-80, the Water Resources Planning Act. These further studies will update the framework investigation, be an input to plans of individual states, and become a part of the Western U.S. Water Plan now under study by the Bureau of Reclamation, Department of the Interior, in accordance with section 201 of Public Law 90-537, 90th Congress, 2nd Session, Colorado River Basin Act.

The legislative charge to the Pacific Northwest River Basins Commission under the public law referred to above, specifies that the Commission shall prepare and keep up to date, to the extent practicable, a comprehensive, coordinated, joint plan. Accordingly, there is an adequate continuing process for maintaining the plans and programs developed by this study as a viable framework for planning and managing the region's water and related land resources.

Some specific measures required for implementation are:

1. Acceleration of Ongoing Programs. Although most of the planned early action work is a continuation of current programs, many of them must be increased sufficiently to accomplish as much or more in the next 50 years as has been accomplished to date. Examples are studies of rivers for recreation and fish purposes, watershed protection and land measures, and of the coastal zone and estuaries. Most of these studies have either not been undertaken or were inadequate in the past; consequently, there is a large unmet need currently facing the region. If such studies are not undertaken in the next few years, the resultant delays in the early action study program will be reflected by increased programs in later time periods.

2. Studies. Prior to actual implementation of a project or program a Federal or State agency would complete specific authorization studies.

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3. Legislative Changes. Some legislative additions and changes may be required in both Federal and State areas. This aspect is discussed in subsequent sections.

COSTS AND SCHEDULING

The average annual level of funding needed in each time period to fulfill the region's projected water and related land resource needs is shown on table 38.

Table 38—Federal and Non-Federal Program Costs
Columbia-North Pacific Region

	1970-1980	1980-2000 (millions)	2000-2020
Federal			
Total Investment	6,340	6,118	5,252
Annual Investment[1/]	634	306	262
Annual Operations, Maintenance and Replacement	42	51	45
Non-Federal			
Total Investment	5,919	6,989	6,799
Annual Investment[1/]	592	349	340
Annual Operations, Maintenance and Replacement	187	182	190

1/ Total investment averaged over time period.

During the 5 years of 1965 through 1969, Federal investment in water and related land resources has averaged $268 million annually. Federal expenditures at more than twice that rate would be required to meet the fund requirements of the early time period. In the later periods, this rate would decrease to near that of the past. Although no estimate was made of past non-Federal expenditures, it is reasonable to expect that a similar pattern of increase would be required. Figure 40 illustrates the approximate percentage of costs for main items of the early action program, 1970 through 1980, and for the total through 2020.

The framework plans and programs meet a need based on projections of possible future conditions derived primarily on a nationwide basis. These projections were not taken as goals or objectives or used as an assumption that past trends will continue in the future. They were used as a baseline or level of reference for further resource planning, protection, or development. This use yielded an early action program for the 1970-1980 time period requiring expenditures of $6.34 billion in Federal funds and $5.92 billion in non-Federal funds, a program which is so large that it is unlikely to be totally implemented by 1980 because of time and budgetary constraints.

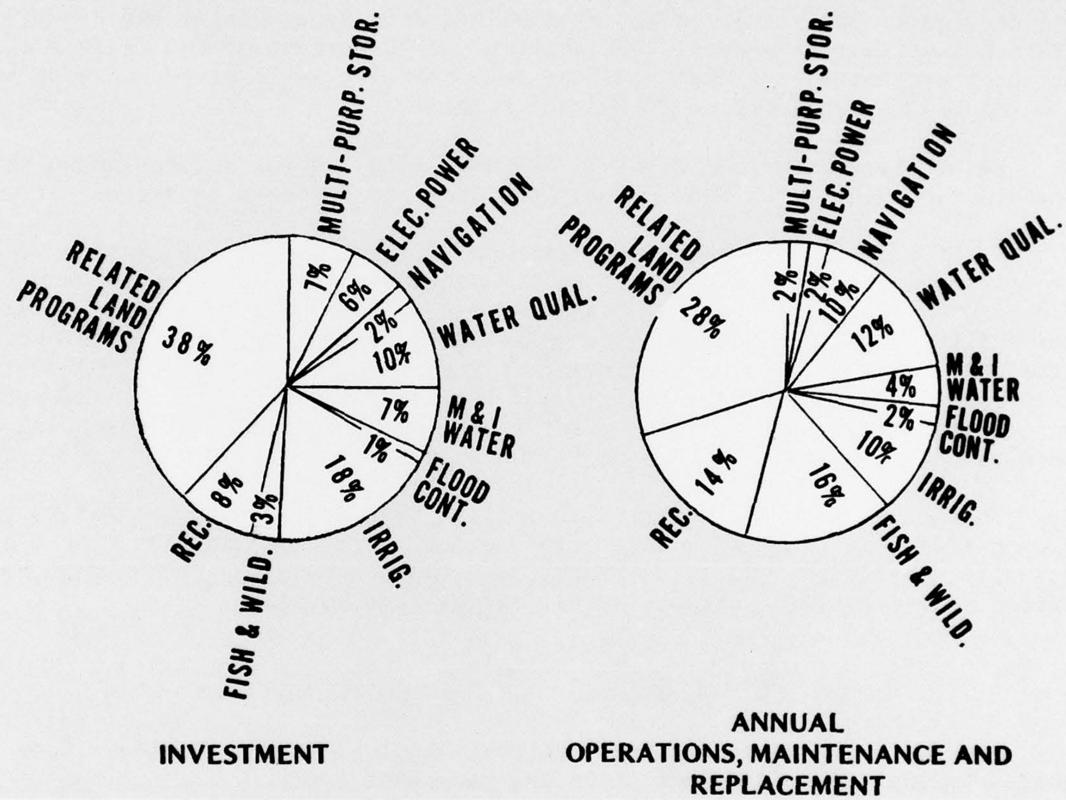

FIGURE 40. Total Investment and Annual OM&R Costs

The largest investment would be in related land programs, irrigation, and reservoir storage, which would represent more than 60 percent of the total investment by 1980 and by 2020.

The high cost of an early action related land program results from emphasis on restoration of badly eroded crop, forest, and range lands to regain full productivity. Delays would cause continuing erosion and sedimentation problems that the programs are designed to curtail.

The large funding requirement in the early action program is influenced more by irrigation than any other one function because of its direct relation to the food and fiber projections. The only Federal irrigation projects which could probably be implemented during the initial period are those already under construction, those authorized for construction, or those for which basic planning is complete. If all of those projects could be in operation by 1980, they would satisfy about 30 percent of the projected 1980 need for new irrigation, and firm up water supplies to about 14 percent of the water-short lands. If private

development maintained its past level of development, about 30 to 40 percent of the 1980 requirements could be met by that source. By combining the Federal and private potentials, it appears that about 60 to 70 percent of the early action irrigation program is all that could be realistically anticipated and even this would require an acceleration of Federal programs.

Reservoir storage is largely associated with Federal irrigation so their priorities would be determined by projects they are designed to serve.

For the most part, the other elements of the early action phase of the framework plan represent a level of achievement which should be approached if at all possible. Electric power is sized to meet the load growth of the region. Water quality and municipal and industrial water supply programs are essential to the well-being of people. The relatively small navigation and flood control elements are considered to be a minimum. The level of the water related recreation planning should be expanded. Fish and wildlife measures are essential to retain this resource and to enhance it where possible.

Further studies are required to realign the early action program to place the less important items in a later time period. For the most part, these adjustments will be made in studies culminating in the comprehensive joint plan being prepared by the Pacific Northwest River Basins Commission.

INSTITUTIONAL AND LEGISLATIVE CONSIDERATIONS

The following describes institutional and legislative considerations required to implement framework plans and programs.

State Considerations

All states should enact land use and surface water zoning laws, with provision for state action if local governments do not implement adequate controls. Special attention is needed to the use and protection of riverbanks and streambeds, marine waters and shorelands; and to flood plain zoning, industrial and urban development, land drainage, agricultural lands, public access, open space and greenbelts; and requirements for urban renewal projects.

Legislation should be passed to improve participation in comprehensive planning at the local level.

Procedural arrangements should be established to finance state and local participation in investigations associated with program and project implementation studies. Consideration should be given credit assistance, financial assistance, and grants-in-aid to many small improvement districts and small municipalities and counties to enable sponsorship of the installation and maintenance of improvements. The state should provide this assistance including objective

consultation and supervision, this providing a needed degree of stability. Principal areas where help is needed include securing rights of way, coordinating works of development, and adding features to small, single-purpose developments that benefit the general public.

States should adopt a more up-to-date approach to state water law with respect to definition and recognition of beneficial uses including instream, that would ultimately permit establishment of realistic minimum and optimum flows. This should include a review of current water rights.

Thermal plant siting entities should be established to control and satisfy the projected tremendous increase in electric power demands, and the consequent need for development of thermal generating plants.

Federal Considerations

Agencies should be authorized to provide technical assistance, training, research and development, and grants to state and local government for public water supply.

Statutes relative to the location and clearance of bridges and causeways in the navigable waters of the United States, contained in Title 33, U. S. Code, should be modified to clarify the Rivers and Harbors Act regarding responsibility for and funding of necessary alterations of bridges and causeways in the way of proposed waterway modifications.

The present authority of the Secretary of Agriculture under Section 216 of the Flood Control Act of 1950 should be expanded so that following a natural disaster, emergency programs to rehabilitate the resource could begin in a more timely manner with the assurance that sufficient funds are available.

Legislation and policy governing Indian trust or restricted land should be changed to facilitate and permit inclusion in, and assessment for operation and maintenance, betterment, and construction by any diking, drainage, flood control, flood control zone, irrigation or other improvement district that may be formed.

Existing statutes governing Federal participation in recreational activities should be amended to establish funding and administrative authority relative to beautification, conveyance of Federal surplus lands for recreation purposes, water and sewage treatment facilities, other water quality control measures, and to coordinate with other Federal, State, and local outdoor recreation plan needs, and capitol improvement programs.

Legislation is needed to further fish and wildlife conservation and enhancement where statutes for the conservation and enhancement of fish and wildlife are not already in force. This would include:

1. Providing zoning for open space, greenbelt, and fish and wildlife, and include retention of Federal lands in public ownership.

2. Recognizing the states' authority to manage resident fish and wildlife. Broader based financial support for state fish and game programs should be provided.

3. Providing fish and wildlife habitat retention on Federal water development projects and on other Federal project lands when at all compatible. This would reduce losses to food, cover, and living areas essential to these resources.

4. Requiring that a share of project lands in newly developed agricultural areas be retained in public ownership; these lands to be dedicated to wildlife habitat and to public use for hunting or other recreational activities.

5. Providing legislation for acquisition of public streambank access downstream from water development projects.

6. Requiring replacement in kind, when possible, of publicly owned fish and wildlife resources and habitat similar to the current policy of replacing publicly and privately owned utilities, townsites, and other features or structures.

ADDITIONAL STUDIES

The nature and extent of required further studies are discussed individually under Area Plans and Regional Framework Plans and Programs. Table 17, Composition of Framework Plans and Programs, lists these studies by general categories. The following describes the implementation of each study category.

Coastal Zone and Estuaries

The coastal zone and each estuary needs coordinated plans to insure that these resources continue to perform their natural function in maintaining ecological balance and yet provide esthetic, recreational, and economic benefits. Required studies include updating existing development and economic, chemical, hydrologic, and biological studies. The studies would integrate the expertise of educational institutions, State and Federal agencies, and managerial techniques into a program flexible enough to meet changing future conditions and backed by legislation to permit full implementation. The States of Oregon and Washington are moving toward achieving the requisite planning and control by legislation enacted in 1971.

Watersheds

The watersheds listed below have been identified as requiring measures and practices to reduce erosion and sedimentation, conserve and improve water quality, or alleviate flood damages and wetness problems. One or more of these problems in the identified watersheds requires solution through a combination of management practices, land treatment, and structural measures on a cooperative basis.

State	Watersheds Identified
Idaho	200
Montana	61
Oregon	216
Washington	407
Wyoming	9
Nevada	3
Total	896

The inventory data for these watersheds must be refined and evaluated to select those which are justified and locally desired to meet needs.

River Basins

Interdisciplinary studies of 14 river basins or subareas are a part of the framework plans and programs. These interdisciplinary studies will be accomplished as a part of the Pacific Northwest River Basins Commission comprehensive joint plan of the Pacific Northwest. This study will begin in fiscal year 1972 pursuant to authority granted in Public Law 89-80, section 201(b)(2) and is sched-scheduled to be completed in 1977.

Special Studies

The many special studies required to obtain facts for planning would be made under the leadership of the agency having the paramount interest, responsibility, or expertise. Some of these investigations would be required to obtain data for river basin studies. Others would be source of information for state, local, or individual agency programs.

The determination of minimum flows and flood plain information studies appear to be the most significant and consequently have a high priority. In some areas, planning cannot proceed until minimum instream flows have been agreed

upon. Flood information studies are the key to managing flood plains by providing essential data on high flows.

The determination of water requirements for all Indian Reservations is required to obtain input to basin and state studies.

Studies of irrigation efficiency and mathmatical hydrologic models are needed to obtain facts for planning instream uses as opposed to consumptive uses of water, particularly in Subregions 4 and 5 in southern Idaho. In this area, water is critical and the Snake River Basin contains a complex hydrologic system.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The framework plans and programs were formulated to satisfy water and related land needs with full recognition given to preservation and enhancement of the natural environment. Projects and programs provide opportunities for meeting most of the identified functional needs.

From the standpoint of the overall well-being of the area, unmet needs are not considered to be significant. The failure to meet food production needs in the Snake River Area by not providing full supplemental irrigation supplies could be overcome through accelerated management techniques on presently irrigated lands or by a slight increase in new irrigation either in that area or elsewhere in the region. Remaining flood damages could be partially offset by flood plain regulations or changes in land use.

Environmental and esthetic values would be preserved and enhanced through future studies and developments leading to the establishment of realistic minimum flows on most streams and augmentation of low flows, the designation of additional scenic roads, and the inclusion of streams in State and National systems of recreation streams. These values would also be preserved and enhanced by measures for water quality, flood plain management, fish and wildlife, recreation, watershed management and treatment, and landscape management and control.

Electric power would be provided by additional capacity at existing and new hydroelectric plants, and by new thermal powerplants, and by pumped-storage developments.

Commercial water transportation needs would be met by deepening channels, construction of breakwaters, enlargement of the existing locks, and extension of barge navigation on the upper Columbia River by channel improvements and construction of locks in existing dams if found to be acceptable by recommended interdisciplinary studies. Also, port facilities and moorage and launching facilities for small boats would be expanded as required.

Water quality would be maintained and improved by waste treatment and by requiring cooling ponds, towers, or mechanical draft cooling to eliminate any discharge of warm water into fresh water streams or lakes by thermal electric powerplants. Nitrogen levels in the Columbia and lower Snake Rivers would be reduced to prevent fish losses.

Municipal, industrial and rural-domestic water supplies would be provided primarily by additional withdrawals from existing sources and development of some new sources.

Flood damages would be reduced by flood plain management, flood plain regulation, flood proofing, storage, levees, and channelization.

Food and fiber production needs would be met by providing water to 1.5 million acres of presently irrigated water-short land and over 6 million acres of new irrigation.

Multipurpose storage facilities would be developed to regulate flows for irrigation, flood control, recreation, water quality, power, navigation, and fish.

Some fishery needs would be met by preservation and improvement of habitat, augmentation of the supply by hatcheries, and rearing ponds, and by improved access to streams, lakes, and salt water. Wildlife would be aided by land acquisition or control for preservation and management, improvement of wildlife habitat, production of game birds, and improvement of access.

Recreation needs would be satisfied by water-related recreation development, acquisition of land primarily for urban recreation, and expansion of designated wilderness and primitive areas.

Watershed management and treatment would be accomplished by erosion and sediment control, yield improvement, water and soil conservation, protection, management, drainage, bank stabilization, dikes and levees, channel improvements, detention and check structures, and ponds and small reservoirs.

Further investigations would be made to:

--Develop coordinated management and use plans for water and adjacent lands in the coastal zone and inestuaries.

--Select those watersheds in which there are complex land and water problems, and where the solutions are justified and desired by local interests.

--Choose the best alternatives in fourteen selected river basins or subareas where complex problems, a wide array of alternatives, and lack of available data require interdisciplinary studies.

--Obtain facts for planning by special studies.

RECOMMENDATIONS

A recommendation is made.

1. That framework plans and programs form the basis for the comprehensive joint plan for Federal, State, interstate, local, and nongovernmental development of water and related land resources of the Pacific Northwest River Basins Commission pursuant to section 201 (b) of Public Law 89-80, the Water Resources Planning Act. Further studies should update the framework investigation and provide an input to plans of individual states and become a part of the Western U. S. Water Plan.

2. That framework plans and programs be adopted for general use for planning by state and local agencies and as a supporting document for individual Federal agency authorization reports.

3. That ongoing studies and programs for management and development of water and related land resources be accelerated.

4. That legislative changes and the studies proposed in the section on Implementation of Framework Plans and Programs, be given high priority, with special emphasis on providing legal and administrative means for enforcing minimum streamflows.

5. That projects and programs required to meet near-future projected needs be implemented through appropriate action by involved agencies and interests.

6. That Pacific Northwest River Basins Commission foster a periodic review and updating of the framework plan to maintain it as a viable planning guide.

PARTICIPATING STATES AND AGENCIES

STATES

Idaho
Montana
Nevada
Oregon
Utah
Washington
Wyoming

FEDERAL AGENCIES

Department of Agriculture
- Economic Research Service
- Forest Service
- Soil Conservation Service

Department of the Army
- Corps of Engineers

Department of Commerce
- Economic Development Adm.
- National Oceanic & Atmospheric Administration
  - National Weather Service
  - National Marine Fisheries Service

Department of Health, Education, & Welfare
- Public Health Service

Department of Housing & Urban Development

Department of Transportation

Department of the Interior
- Bonneville Power Adm.
- Bureau of Indian Affairs
- Bureau of Land Management
- Bureau of Mines
- Bureau of Outdoor Recreation
- Bureau of Reclamation
- Fish and Wildlife Service
- Geological Survey
- National Park Service

Department of Labor

Environmental Protection Agency

Federal Power Commission